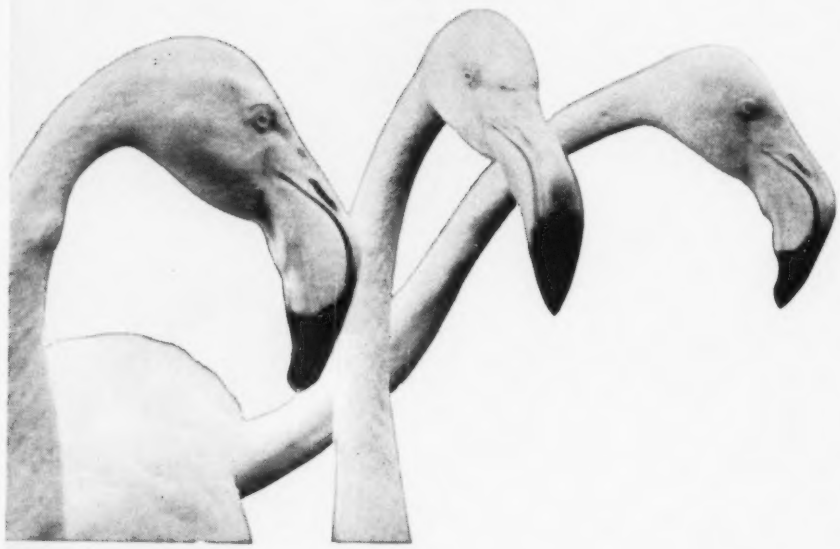
1 MAY 1959

METAL INDUSTRY

THE JOURNAL OF NON-FERROUS METALS



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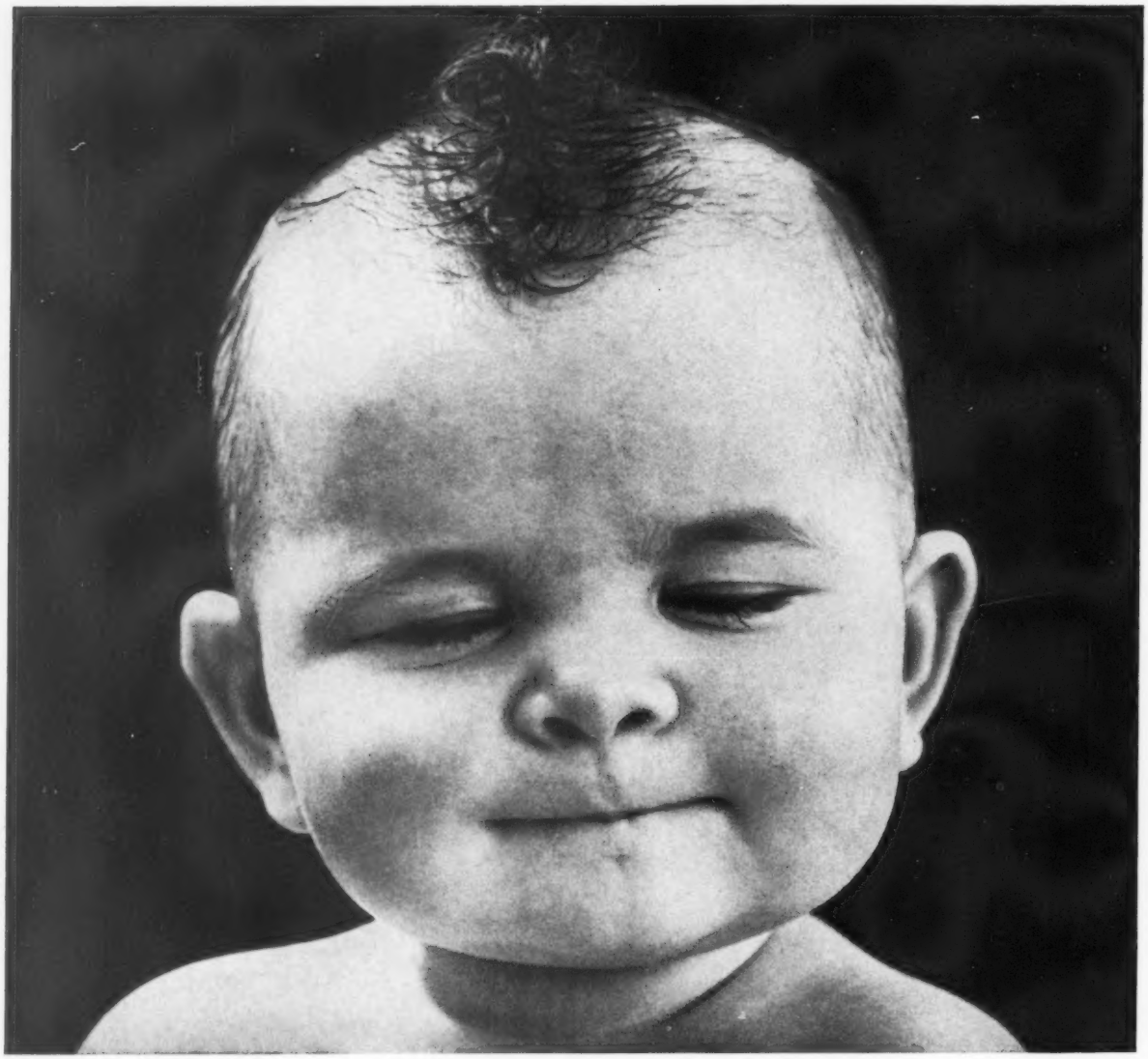

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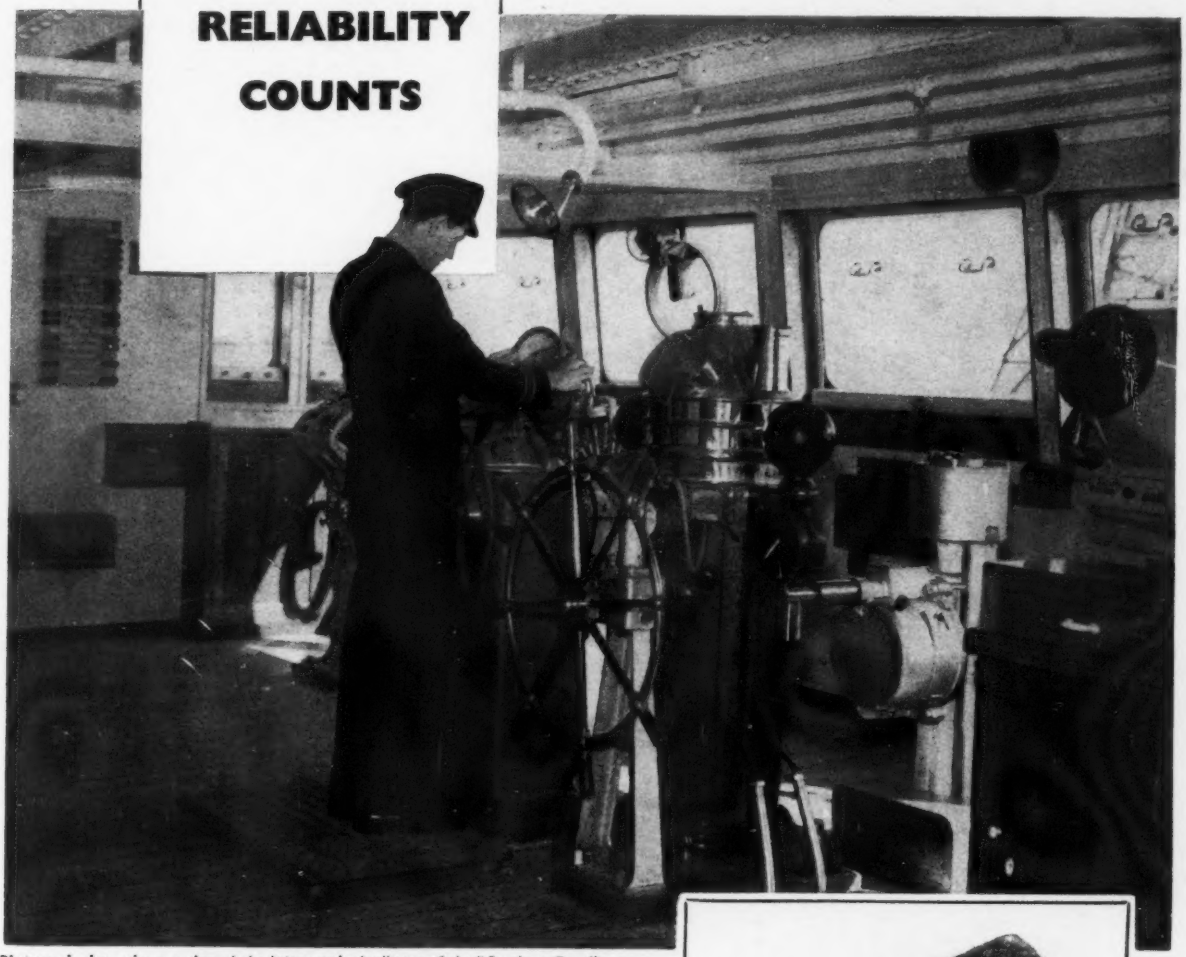

Photograph above shows a view of the bridge and wheelhouse of the "Southern Cross"

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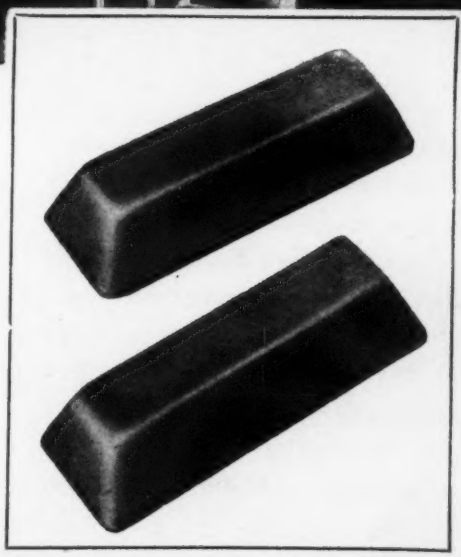

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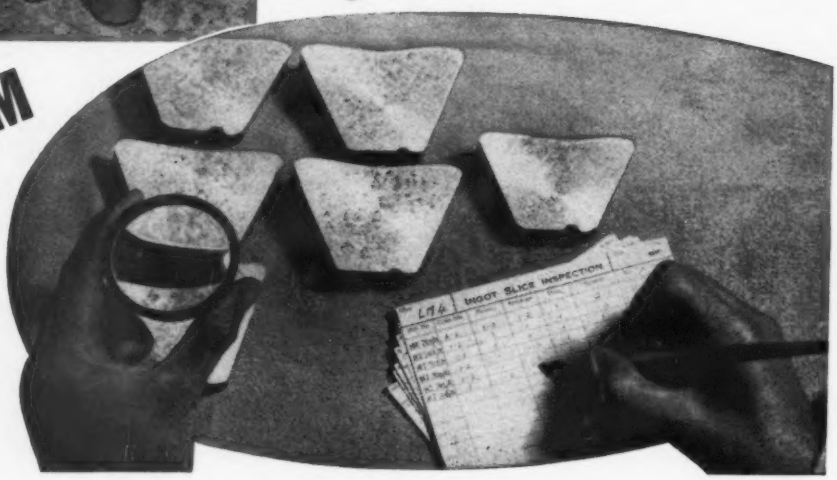

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Light Alloy Ingots

These illustrations are taken from the latest Intal booklet, giving much interesting information on alloy ingot manufacture. We shall be pleased to post a copy to executives on request.

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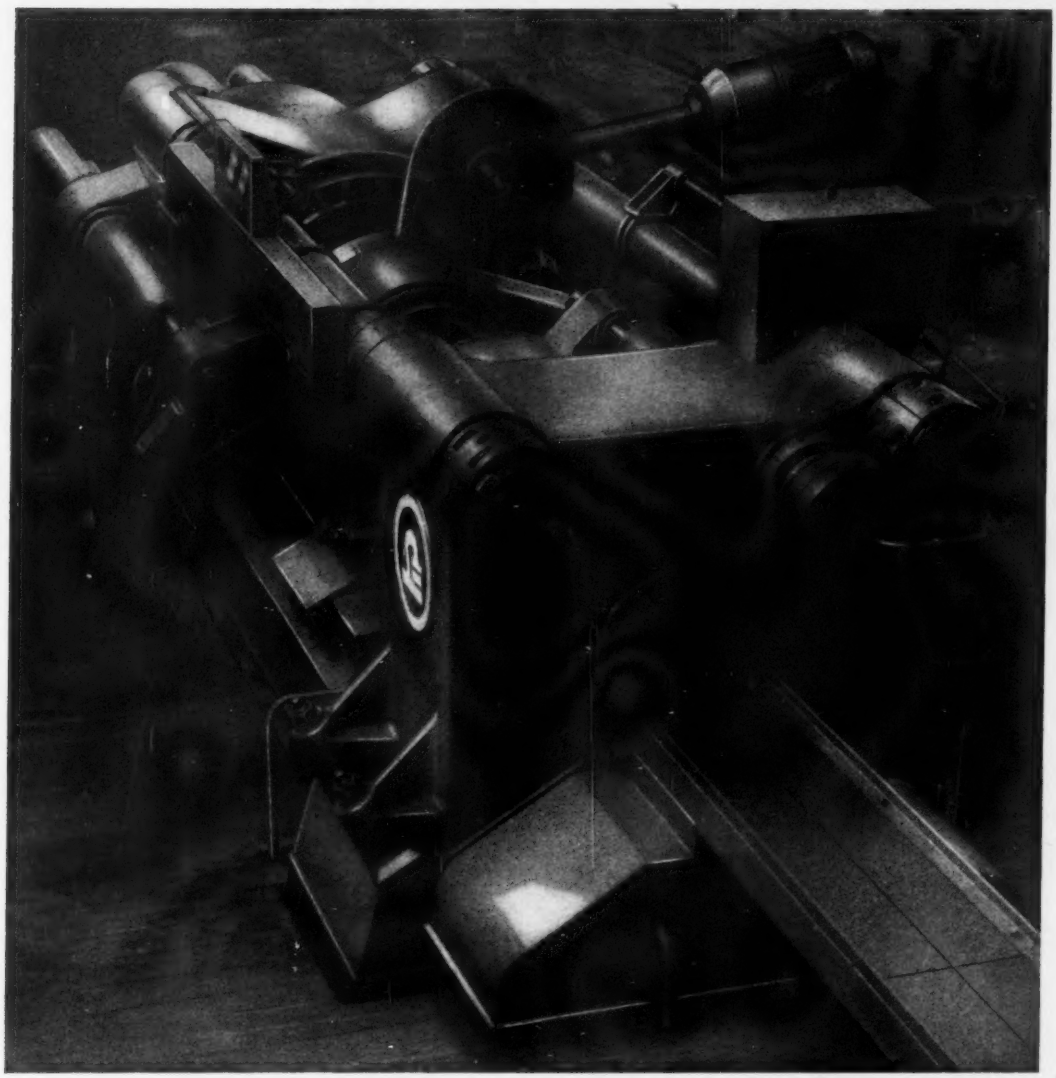

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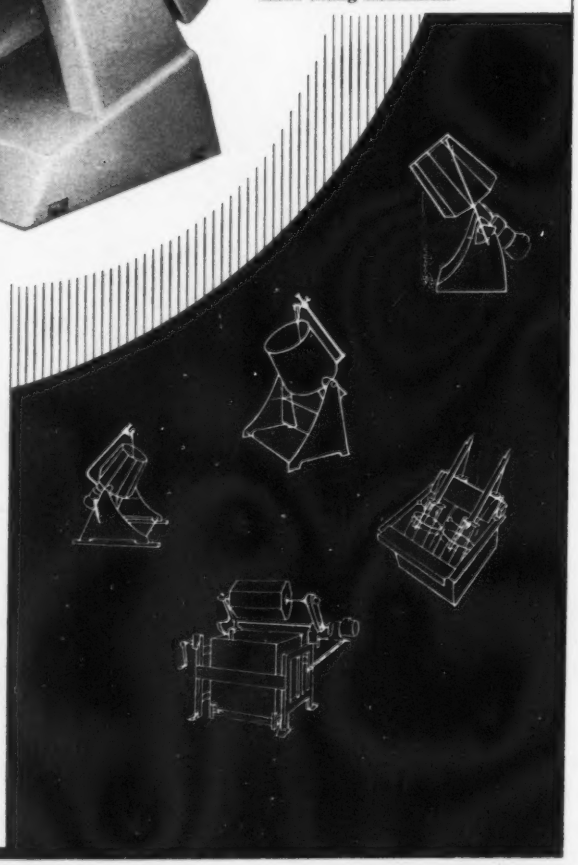

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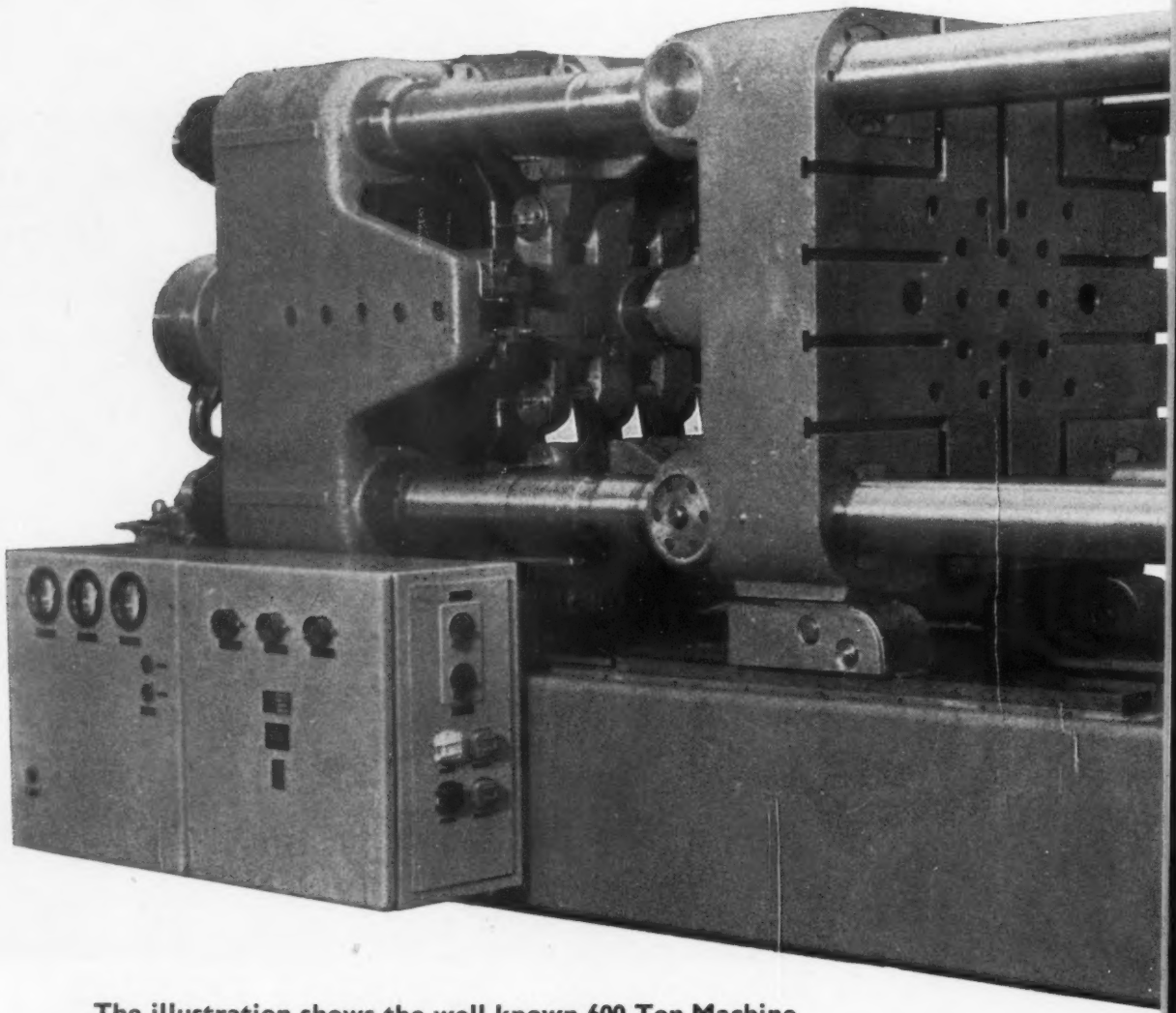

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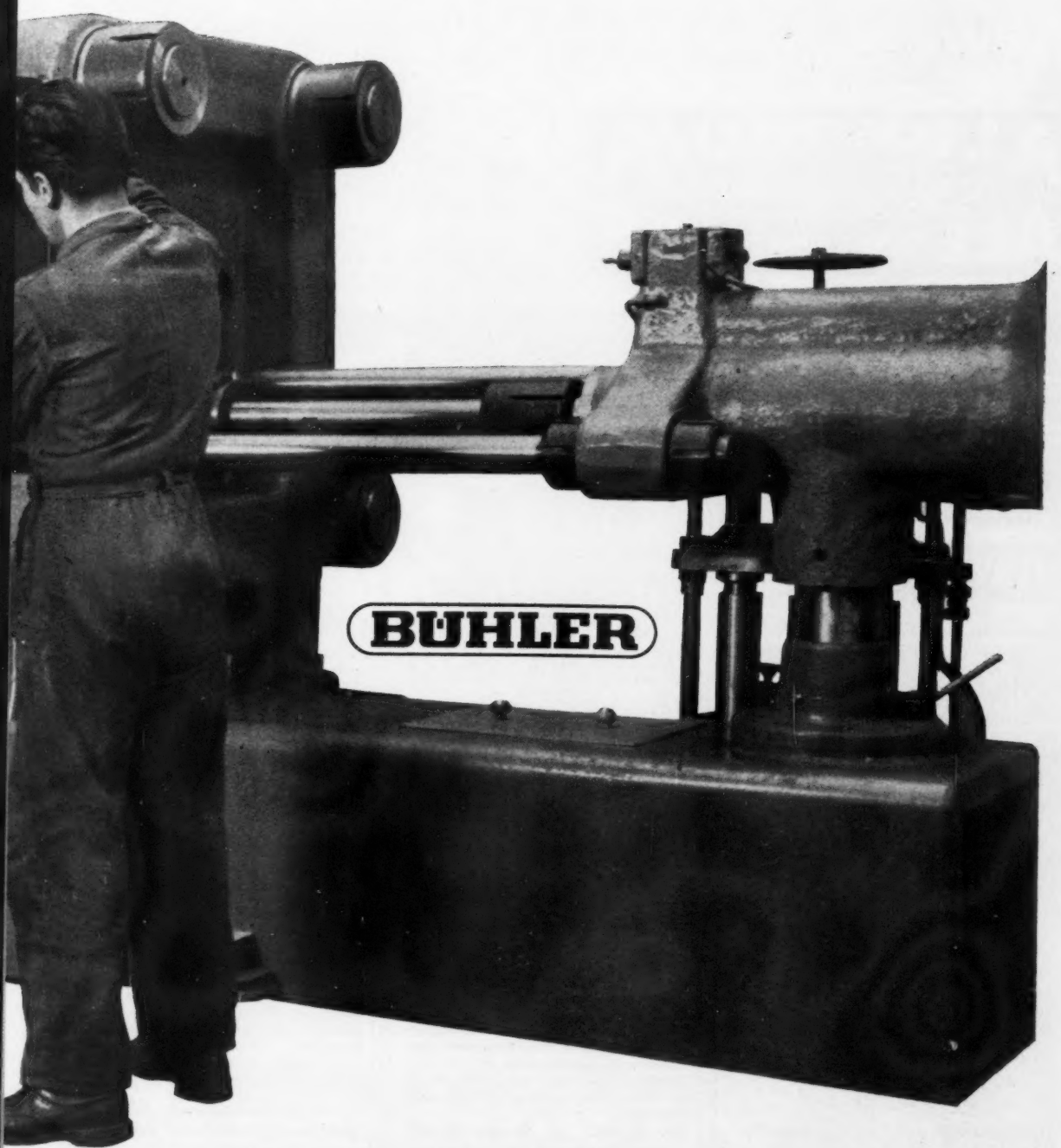

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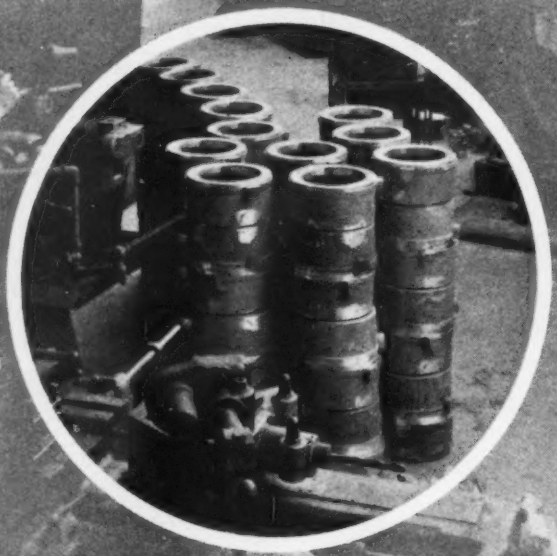

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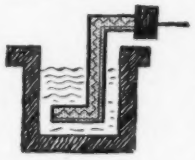
Electrical Aids in Industry *Data Sheet* **No. 5**

Resistance Heating – 2

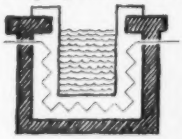
Electric resistance heating elements have been briefly described in Data Sheet No. 4, with two examples of their application in industry. This sheet lists some of the further applications which can be effectively dealt with by resistance heating.

Soft Metal Melting

Electric resistance melting is most commonly used for lead, tin, zinc, antimony, aluminium and their alloys—in processes such as tinning, type-casting, die-casting and lining bearings—at temperatures of up to around 800°C.



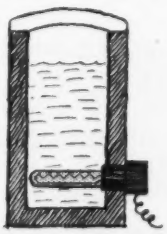
In most cases, sheathed elements are immersed directly in the metal, a more efficient method than applying heat to the outside of the containing vessel or pot. Immersion heating simplifies the application of lagging to the outside of the vessel, reducing heat losses and current consumption to a minimum. The elements are usually positioned near the inside wall of the vessel, leaving plenty of working space, but in a few cases, where the full volume of the pot is required, or where the metal to be melted is particularly corrosive, the elements are positioned outside the pot, often in contact with it.



In all cases, the precise temperature control that is so essential in soft metal processes is readily achieved by the use of electricity, and electric heating also leads to a reduction of casting rejects and metal wastage and a marked improvement in working conditions.

Liquid Heating

Electricity provides the ideal way of heating liquids such as water, oils, varnishes, plating, photographic and other solutions, and of melting and heating waxes and compounds, glues and pastes, tars and bitumen. Again, immersion heating is the method most commonly employed, but considerations of space or the nature of the liquid may sometimes necessitate the use of external heaters. Several types of devices are available to give precise and automatic temperature control, and lagging is again commonly applied to the vessel to minimise heat losses.

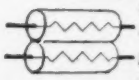


Fire hazards associated with inflammable liquids are invariably reduced by electric heating, particularly if immersion heaters can be used.

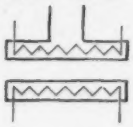
It is usually possible without difficulty to apply electric heaters, either immersion or external, to existing vessels.

Platen, Press and Roll Heating

Electricity offers the simplest and most convenient method of heating platens, dies and rolls. It gives the precise temperature-control characteristic of electric heating systems, with lower maintenance costs. Moreover, the relatively high temperatures required in some processes for maximum working speeds are reached without difficulty. Flexible electrical connections to moving parts give far less trouble than flexible pipe connections carrying hot water or steam.

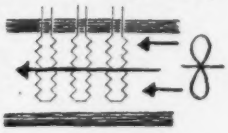


When electric heating is used, one or more presses can be operated without the necessity of keeping a boilerhouse staff at work.



Air Heating

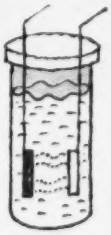
Streams of air, and of many other gases, can be heated most efficiently by electric resistance elements disposed across the duct leading to or from a fan. Heat is generated only inside the duct, just where it is required, and none is carried away through exhaust flues or pipes. Quick rise of temperature and precise temperature control are assured when electric resistance air heaters are used.



Electric Steam Boilers and Steam Raising

There are many cases when the use of electricity for steam raising is fully justified on economic grounds.

The means employed for bringing steam from a boilerhouse to the point of usage are often extremely wasteful, but where electricity is used the steam can be generated on the spot and losses from steam mains are eliminated. The efficiency of the electric boiler normally exceeds 96% and is practically constant at all loads, while the rapidity with which steam can be raised very largely eliminates banking losses.



Plant requiring process steam can be equipped with its own electric steam boiler, freeing the working space of steam mains just as individual electric motor drives free the factory of masses of shafting and belt drives.

Even where boilerhouse steam is still used, it is sometimes desirable for best results to boost the steam temperatures at the point of usage, to make up for transmission heat losses or to increase the superheat, and this function can most conveniently be performed by an electric resistance heater inserted in the steam line.

For further information get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, W.C.2. Telephone: TEM 9434.

Excellent reference books on electricity and productivity (8/6 each, or 9/- post free) are available – "Resistance Heating" is an example; "Induction and Dielectric Heating" is another.

E.D.A. also have available on free loan a series of films on the industrial use of electricity. Ask for a catalogue.

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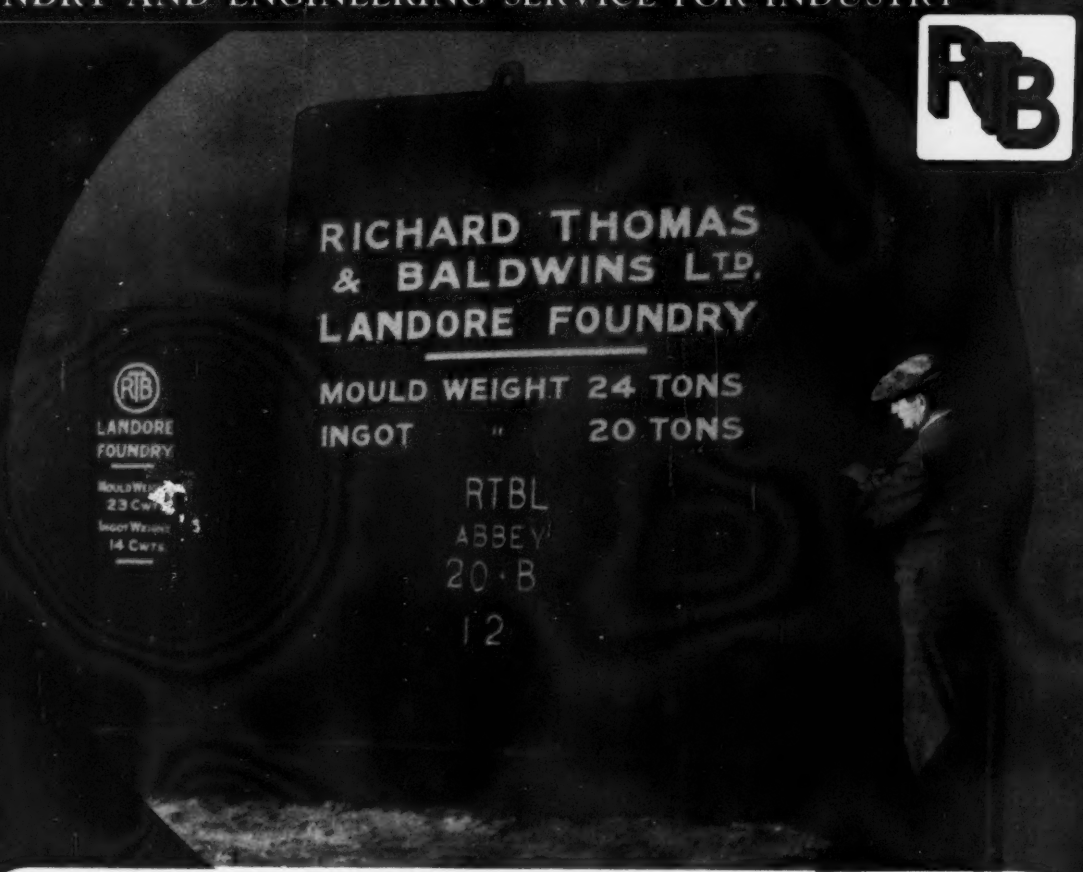

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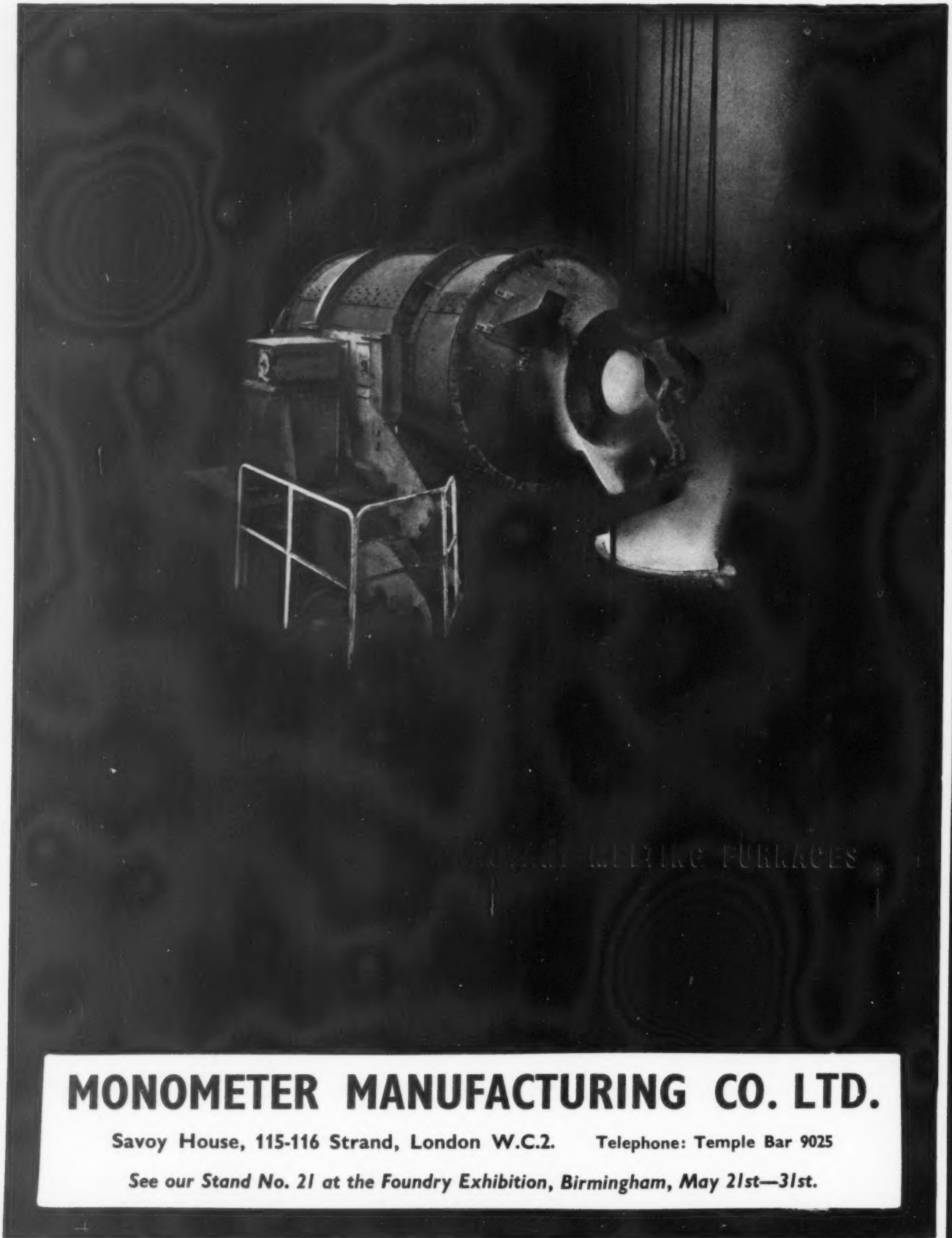

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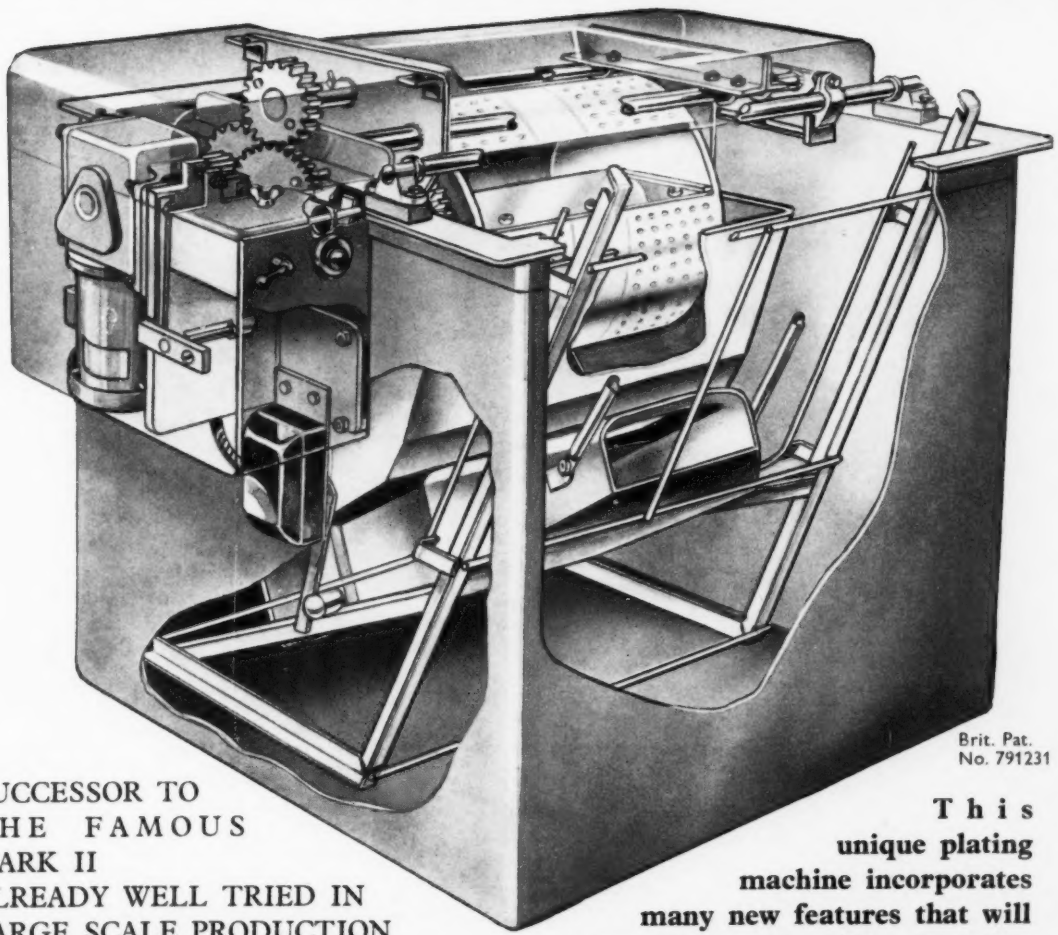

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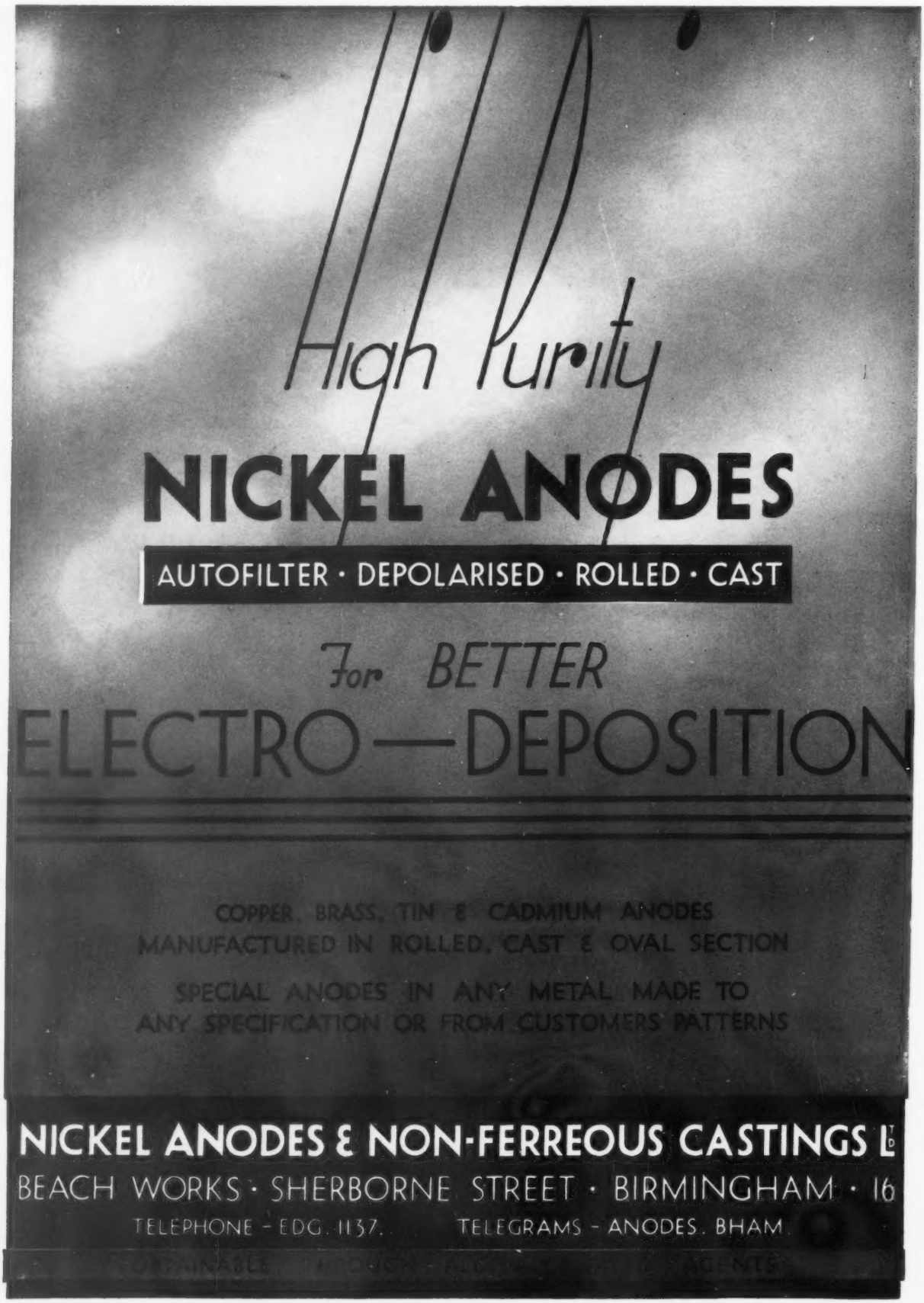
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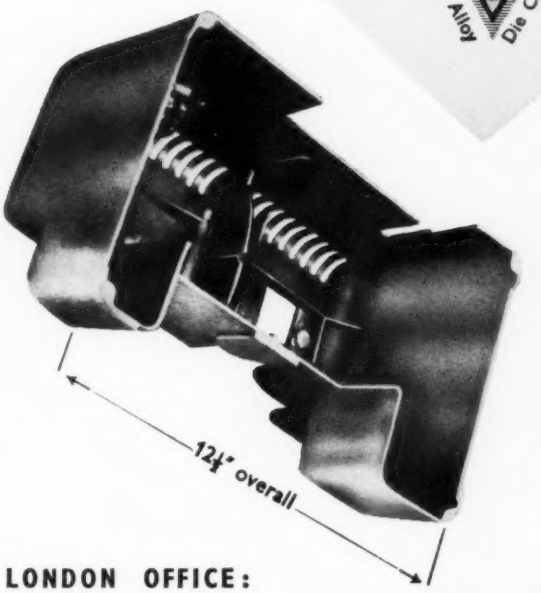

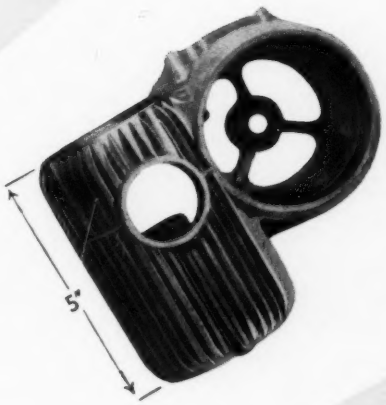

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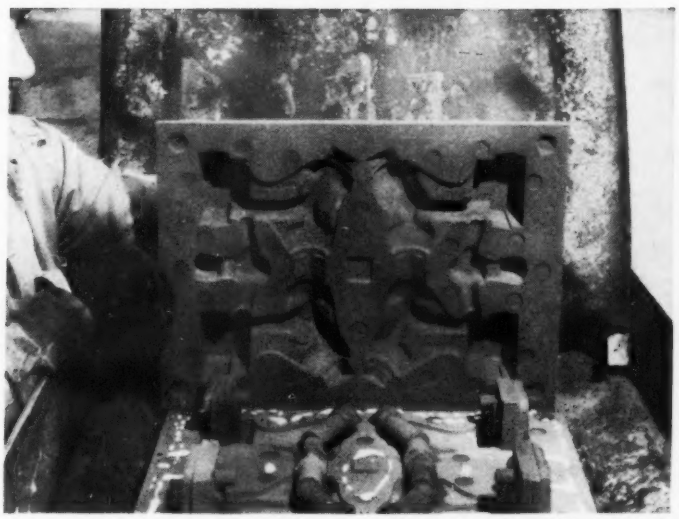

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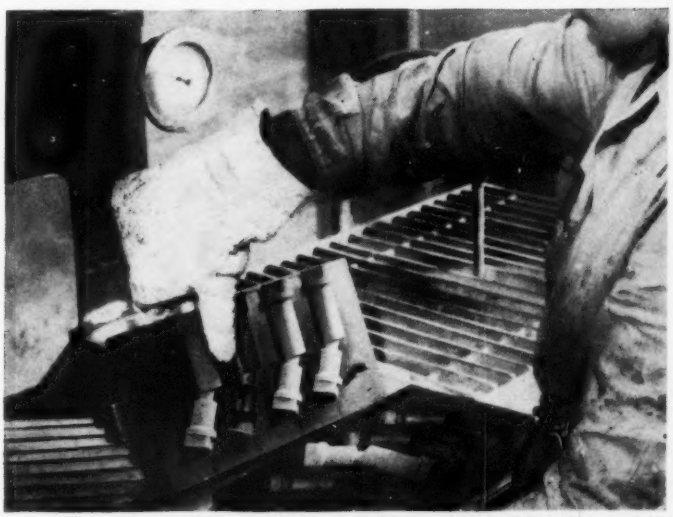

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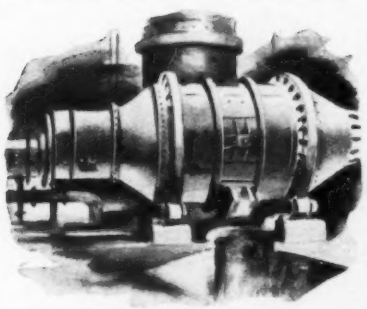

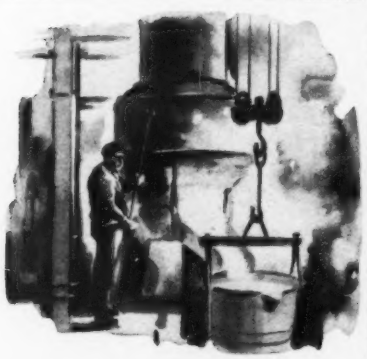

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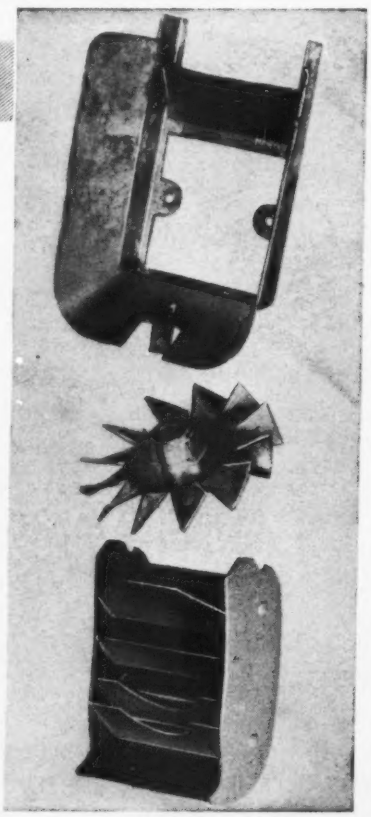

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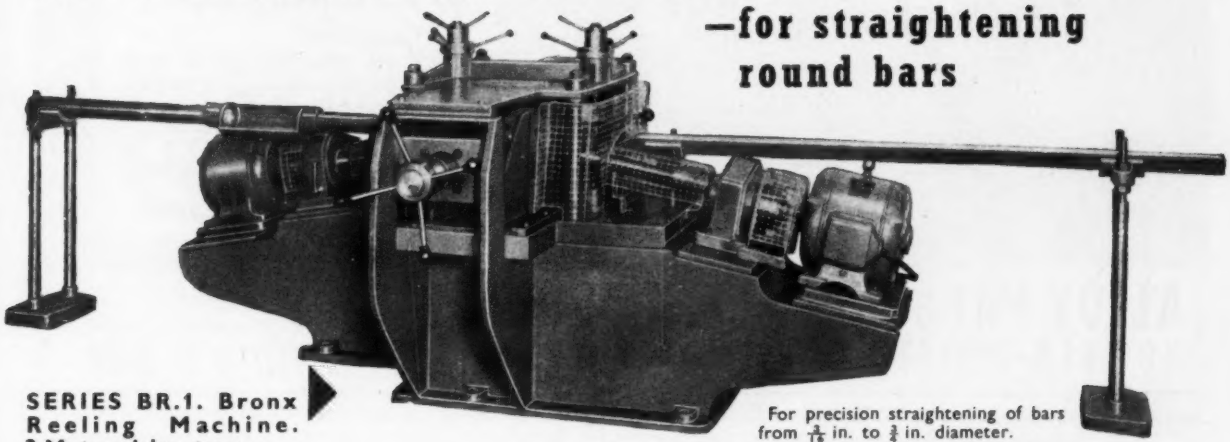

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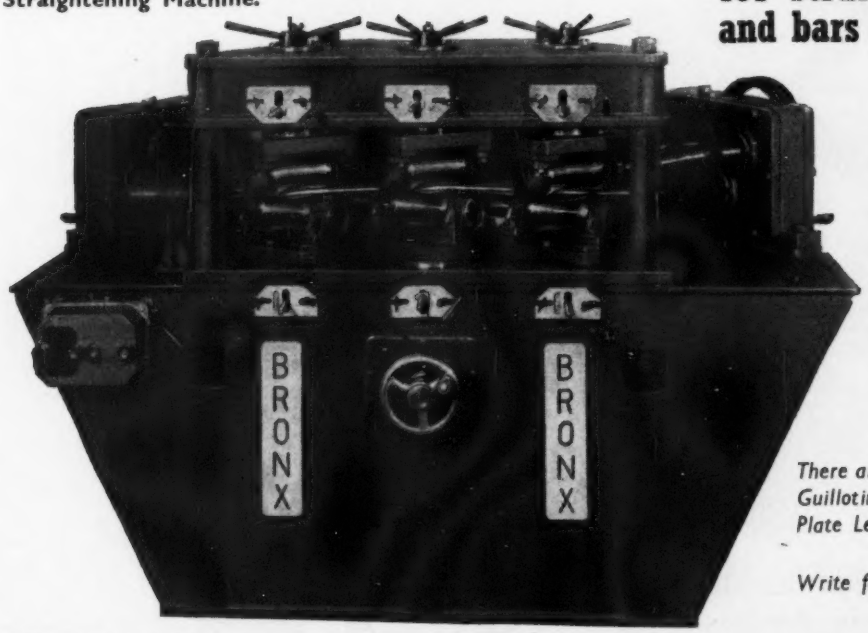

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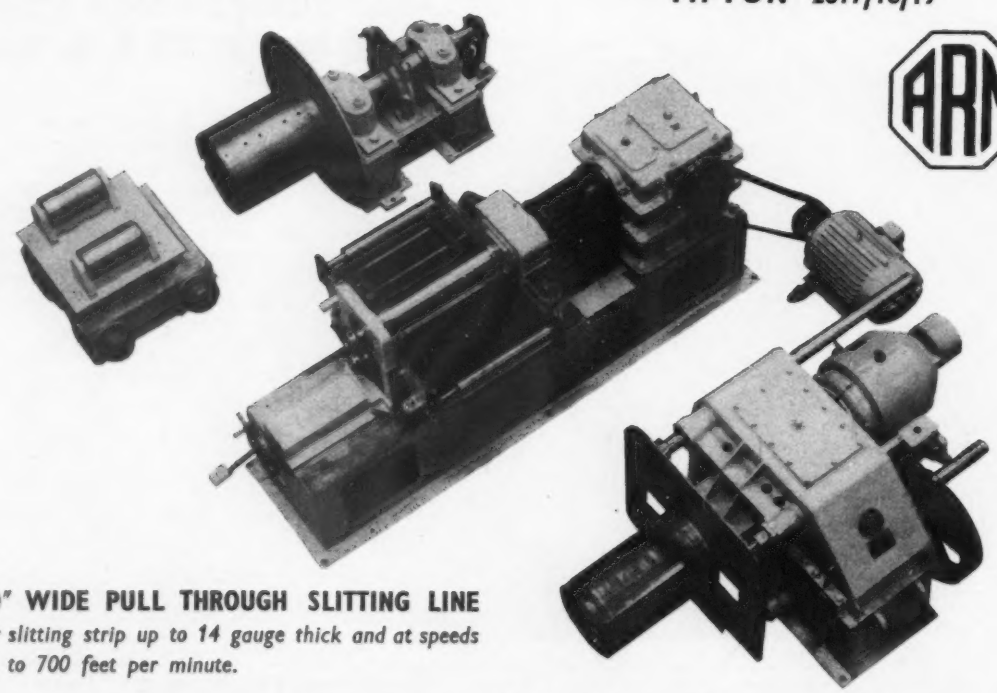

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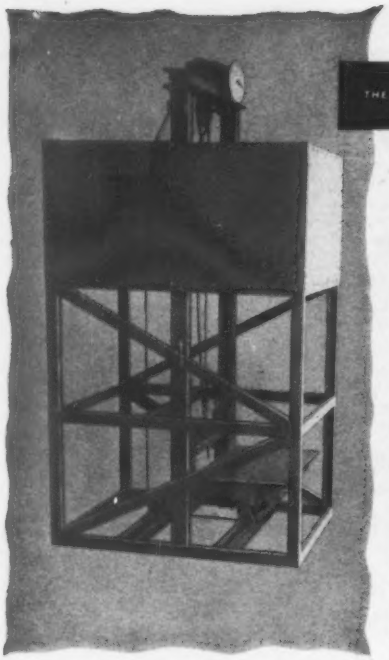

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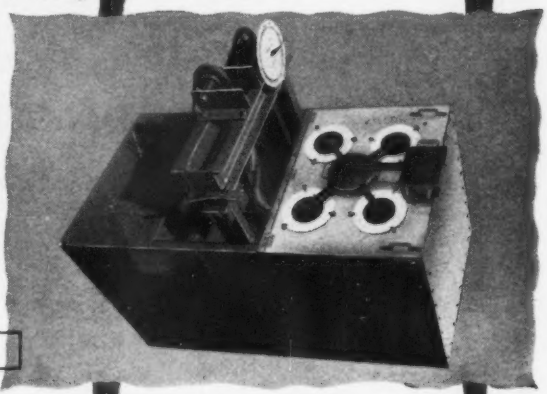

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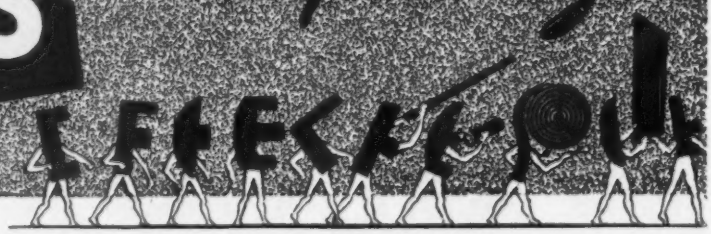

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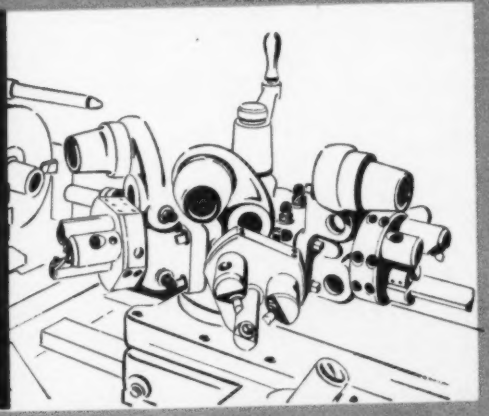

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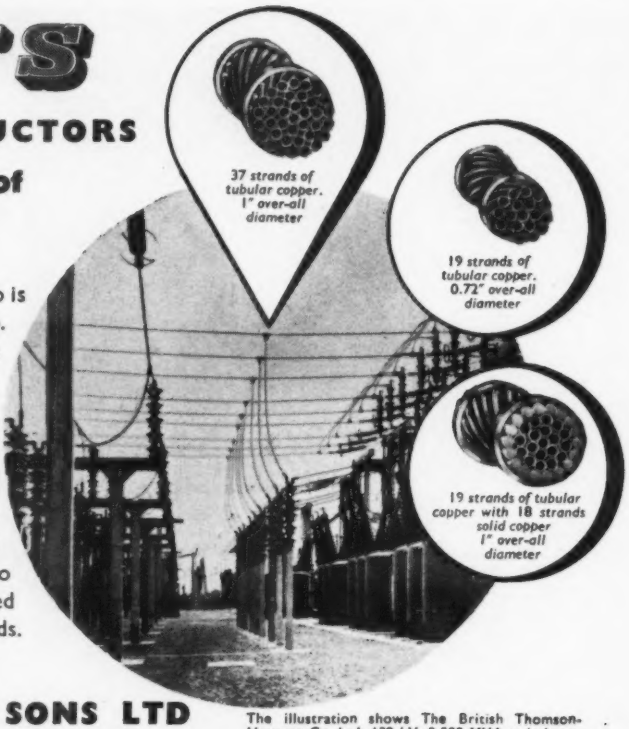
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The illustration shows The British Thomson-Houston Co. Ltd. 132-kV, 3,500 MVA switchgear at Castle Donington Power Station of the C.E.A. (East Midlands) incorporating the 37-strand tubular conductor.
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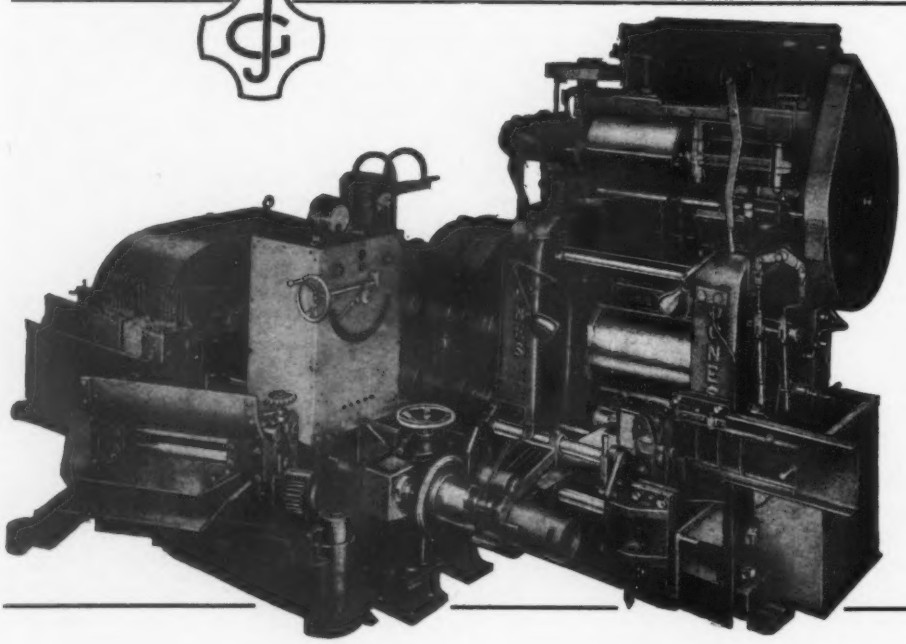

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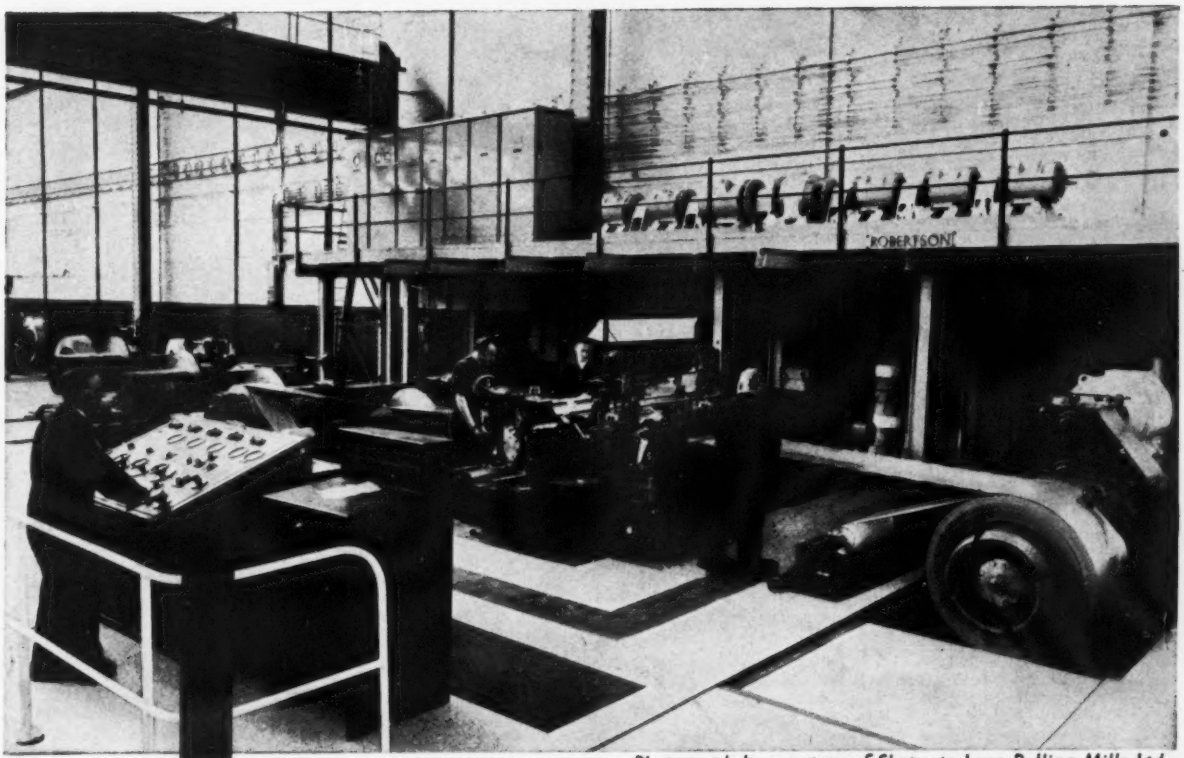

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METAL INDUSTRY

FOUNDED 1909

EDITOR: L. G. BERESFORD, B.Sc., F.I.M.

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METAL INDUSTRY

VOLUME 94 NUMBER 18 1 MAY 1959

Export Trade Facilities

IN the past two decades, although United Kingdom exports have risen from 9 per cent to 17 per cent of the gross national product, our share of total world exports has dropped from 22·1 per cent to 18·1 per cent. How, therefore, can this growing competition from other industrial countries be met? Some interesting suggestions in this connection are to be found in the report on export trade facilities recently published by the Federation of British Industries. Prepared by an independent working party, including representatives of the Association of British Chambers of Commerce, the National Union of Manufacturers and other organizations concerned with export, the report covers the training of salesmen, export market investigation, design, packaging, advertising, trade fairs and public relations. Its recommendations in each of these fields are now being studied by the F.B.I. and the Board of Trade.

Among the recommendations in the field of education and training is the suggestion that existing short training courses, "summer schools" and practical demonstrations of sales planning techniques should be extended and their scope broadened in order to give greater understanding of social conditions overseas. Industry could materially assist these by releasing more of its expert sales staff to act as lecturers. Consideration should also be given by the Government, in consultation with the national organizations, to the feasibility of establishing a residential centre for training in the export field. Employers are also recommended to increase the inducements for their salesmen to obtain a knowledge of foreign languages.

With regard to export market investigation, firms are advised to make fuller use of official sources of export information, at home and abroad, and of existing market research facilities. More of the smaller firms, it is suggested, should appoint suitable persons on their staff to take charge of export sales-planning, including the interpretation of market information. Consideration should also be given by the Government and the national organizations to the establishment of "export councils" for the European and other non-dollar markets. More frequent interchange of small fact-finding trade missions between this country and others should be promoted by the national organizations and trade associations in co-operation with the Board of Trade.

On the question of export trade promotion, it is asserted that if the reputation of British goods is to be maintained abroad it is essential to create new and distinctive styles which will compel the world to look to this country for a lead. They must also be attractively and conveniently packed so as to have consumer appeal. It is interesting to note, in passing, that the compilers of the report appear quite satisfied with the present methods for the packing of goods for transportation and storage, a subject which, from the point of view of non-ferrous metals, has been dealt with in detail in recent issues of METAL INDUSTRY. Attention is also drawn in the report to the assistance that can be given to export advertising campaigns by British trade journals, and it is suggested that the Government should endeavour to dissuade certain countries from imposing restrictions on their import and, where currency difficulties exist, should consider plans whereby payment might be made in sterling in the U.K. With regard to trade exhibitions, it is suggested that urgent consideration should be given to the provision of suitable and up-to-date British exhibition facilities near central London, and that more use should be made of any opportunities that might arise for staging small exhibitions of British goods and "prestige" features overseas.

Out of the MELTING POT

Still Growing FURTHER observations made at the Royal Aircraft Establishment, Farnborough, on surface growths and whiskers, this time as part of a general study of the surface deterioration occurring on aluminium-magnesium alloys during heat-treatment, have recently been described. Growths were formed when electrolytically polished specimens of extruded, and extruded and rolled, aluminium-7 per cent magnesium alloy were heated *in vacuo* at temperatures between the eutectic temperature (450°C.) and the solidus temperature for the alloy (520°C.). These solid state growths have a marked crystalline form of hexagonal or rectangular prisms. They are formed at grain boundaries, being sometimes left behind by migrating boundaries. At temperatures very close to the solidus, these growths developed to a marked extent along one axis to form whiskers having a geometric section and a tip constituted by a crystalline facet. Their magnesium content was found to be lower than that of the parent alloy, probably due to loss of magnesium by evaporation. On heating above the solidus, profuse whisker growth occurred over the whole specimen surface. The whiskers were polycrystalline, of a fluted form and often branched and divided, and up to several hundred microns in length. They consisted of pure aluminium, again probably as a result of loss of magnesium by evaporation. Ribbon-like growths were also observed to form under these conditions. In accordance with what may be called the R.A.E. school of thought on the subject of whiskers, an attempt was made to eschew the dislocation mechanisms suggested by other investigators to account for whisker growth. An extrusion mechanism is postulated for the sub-solidus growths, with diffusion of vacancies (formed as a result of the evaporation of the magnesium) to the grain boundaries acting as the driving force. Whisker growth at temperatures above the solidus is considered to be a "continuous casting" type of exudation, the change in volume, occurring as liquid is formed, acting against the restriction of the surrounding surface region with a higher liquidus temperature as a result of loss of magnesium by evaporation, providing the driving force for this exudation. In connection with this "continuous casting" picture, the fact is of interest that growth is aided by gravity: more profuse growths occurring on the underside of specimens.

Superfluity MOST of those engaged, in particular, on the research and development sides of industry would agree with the view that there exists a sizeable discrepancy between the work to be done and the time and/or the manpower available for doing it. This problem of allocating priorities is indeed receiving increasing consideration. Where previously research tended to follow up anything that happened to catch the research worker's imagination, to-day, taking up an investigation is likely to be preceded by some evaluation of the likelihood of its "paying off." At a later stage, development of commercial applications of inventions and of the findings of research work—where previously the consequence of a superabundant degree of enthusiasm—are to-day likely to be based on conclusions drawn from careful market surveys. Nothing has as yet been done about providing the ability of turning an imperturbable blind eye on opportunities—real or imaginary—that have to be passed by. This still remains a matter for the individuals themselves, though the need for it is being greatly diminished by all the forward planning, sifting of priorities, and business planning activities just mentioned. As these are perfected and their scope increased, possibly as a result of the introduction into this field of electronic computers, a progressive restoration of the present-day out-of-balance situation to something approaching equilibrium may yet be achieved. Thus, to mention but one possibility, the volume of published information may yet be arranged to match rather than choke the facilities available for profiting by it.

No Stopping X-RAY examination and measurements of the electrical conductivity showed that aluminium of very high purity, as obtained by zone melting, is capable, after cold working, of recrystallizing at temperatures considerably below room temperature. There was, of course, no reason to doubt this evidence, especially in view of the fact that it was in accord with the previously well-established trend of the recrystallization temperature of aluminium to fall with increasing purity of the metal. Nevertheless, direct evidence of low-temperature recrystallization, obtained by the usual procedures involving microscopic examination of the metal, appeared most desirable. The main difficulty in this connection was the fact that recrystallization of the cold worked metal occurred during the usual electrolytic polishing of the specimens before it was possible to examine them. This difficulty was eventually overcome by the development of a technique of preparing the specimens at really low temperatures. The specimens were polished electrolytically in a mixture of 200 mL of pure nitric acid and 800 mL of methyl alcohol, the bath being cooled to −60°C. by circulating liquid nitrogen around the cell. After polishing, the specimens were anodized in a mixture of 150 mL of pure nitric acid and 850 mL of methyl alcohol, again cooled to −60°C. Under these conditions, the temperature of the specimens did not exceed −50°C. during polishing and −58°C. during anodizing. The specimens prepared in this way were examined under polarized light. The above technique made it possible to observe recrystallization and grain growth which occurred in the cold worked metal on "annealing" at −47°C. and −38°C. It should be noted that "cold worked" in this case really meant *cold* worked: the rolling mill was placed in a cold chamber at −18°C. and the specimens were cooled in liquid nitrogen before and after each pass. A total reduction of 97 per cent was given. That even these precautions did not stop some recrystallization, is shown by the fact that for some specimens, which had been cold reduced 97 per cent with the rolls and the specimens completely immersed in liquid nitrogen (−195°C.), the recrystallization temperature was found to have been reduced from −38°C. to −52°C. The fact that even this is not the limit for structural changes in this high purity cold worked metal is shown indirectly by the changes in electrical resistance which occurred in specimens held at −78°C., at which temperature, however, X-ray and microscopic examination failed to detect any traces of recrystallization.

Skimmer

Institute of Metals

Spring Meeting

FOR its Spring Meeting this year, the Institute of Metals met in London, the venue being Church House, Great Smith Street, Westminster. As is customary, the chair was taken by the President, **Lord Tedder,** who welcomed members and visitors from overseas. The secretary (**Lieut.-Col. S. G. Guillan,** T.D.) announced that since the Autumn Meeting 209 new members had been elected. The secretary also announced that the 1959 Autumn Meeting will be held in Sweden and Denmark from September 21 to September 29.

The chairman then moved the adoption of the report of the Council, the motion being approved.

Presenting his report, the honorary treasurer (**Mr. J. C. Colquhoun,** M.B.E.) moved the adoption of the accounts, and **Mr. R. D. Hamer,** B.Sc., F.I.M., chairman of the Finance and General Purposes Committee, seconded. On being put to the meeting, the motion was carried.

Election of Officers

The secretary then announced the names of members elected to fill vacancies on the Council for the year 1959-60, the new appointments being—President: **G. L. Bailey,** C.B.E., M.Sc., F.I.M. (Director, The British Non-Ferrous Metals Research Association). Vice-Presidents: **Hugh Ford,** D.Sc., Ph.D., Wh.Sch., M.I.Mech.E. (Professor of Applied Mechanics, Imperial College of Science and Technology, University of London); **E. H. Jones,** A.R.I.C., M.I.M.M. (joint managing director, Capper Pass and Son Ltd., North Ferriby); **H. O'Neill,** M.Met., D.Sc., F.I.M. (Professor of Metallurgy, University College of Swansea, University of Wales). Honorary Treasurer: **D. P. C. Neave,** M.A., M.I.Mech.E. (Chairman, The British-American Metals Co., Ltd.; and Director, Capper Pass and Son, Ltd., James Bridge Copper Works, Ltd., and Wolverhampton Metal Company Ltd.). Members of Council: **W. O. Alexander,** B.Sc., Ph.D., F.I.M. (Assistant Research Manager, Imperial Chemical Industries, Ltd., Metals Division, Birmingham). **N. P. Allen,** M.Met., D.Sc., F.I.M., F.R.S. (Superintendent, Metallurgy Division, National Physical Laboratory, Teddington). **F. Dickinson,** B.S.(Eng.), F.Inst.P., F.I.M. (Manager, Development and Research Department, The Mond Nickel Co., Ltd., London); **L. Rotherham,** M.Sc., F.Inst.P., F.I.M. (Research Member of the Central Electricity Generating Board, London).

G. L. Bailey

The Secretary announced that the Council had elected **Sir Ronald Prain,** O.B.E. to serve as Senior Vice-President for 1959-60, and that he would be their nominee for the Presidency in 1960-61.

The chairman then called on **Professor H. Ford,** vice-president, to move a vote of thanks to those who, in accordance with the Articles of Association, had retired from the Council, viz: Past-President: **Dr. Maurice Cook,** C.B.E., Vice-Presidents: **Dr. N. P. Inglis, Dr. Ivor Jenkins,** Ordinary Members of Council: **Dr. L. E. Benson, Mr. C. F. J. Francis-Carter,** O.B.E., and, the motion being put to the meeting was duly carried.

The chairman then introduced the new President of the Institute, **Mr. G. L. Bailey,** C.B.E., M.Sc., F.I.M., and after investing him with the presidential badge, inducted him into the Chair.

The new President thanked the members for his election, acknowledging the honour conferred by holding this position and assuring them of his endeavours to serve the Institute.

The President then called on **Mr. H. W. G. Hignett,** to propose a vote of thanks to Marshal of the Royal Air Force The Right Hon. **Lord Tedder,** for his services to the Institute as President in the Golden Jubilee Year.

This motion, which was received with acclamation, was seconded by **Major C. J. P. Ball,** D.S.O., M.C., past-president.

The Lord Tedder then briefly acknowledged the thanks of the Institute.

The president, **Mr. G. L. Bailey,** delivered his address, excerpts from which appear on the following page.

A vote of thanks to the President for his address was proposed by **Dr. N. P. Allen,** F.R.S., Member of Council, and the motion was put to the meeting, and the President briefly replied.

Awards of Medals

After the reading of the citations, the President presented the Institute's medals as follows:—

The Institute of Metals (Platinum) Medal to **Dr. Leonard Bessemer Pfeil,** O.B.E., A.R.S.M., F.I.M., F.R.S. (Director, The Mond Nickel Co. Ltd.),

Sir Ronald Prain

H. Ford

E. H. Jones

H. O'Neill

D. P. C. Neave

W. O. Alexander

N. P. Allen

F. Dickinson

L. Rotherham

L. B. Pfeil

R. W. K. Honeycombe

R. B. Sims

in recognition of his outstanding contributions to non-ferrous metallurgical science and to the non-ferrous metals industries.

The Rosenhain Medal to **Professor Robert William Kerr Honeycombe,** M.Sc., Ph.D. (Professor of Physical Metallurgy, University of Sheffield), in recognition of his outstanding contributions in the field of physical metallurgy. Professor Honeycombe was unable to receive the medal at this meeting.

The W. H. A. Robertson Medal and Premium to **Dr. Raymond Bernard Sims,** M.I.Mech.E., A.Inst.P. (Chief Engineer, Davy and United Engineering Company, Ltd.) for a Paper on "Automatic Gauge Control in Rolling Mills."

This concluded the business of the Annual General Meeting, and the chairman then terminated the session.

On Tuesday evening, the forty-ninth May Lecture was given at The Royal Institution. The President introduced **Professor F. Hoyle,** M.A., F.R.S. (Plumian Professor of Astronomy and Experimental Philosophy in the University of Cambridge) and called on him to deliver the forty-ninth May Lecture on "The Scientific Uses of Space Exploration."

On Wednesday evening, the Institute held its Dinner and Dance at Grosvenor House, Park Lane, the principal guest being the President of the Federation of British Industries, **Mr. W. H. McFadzean,** who proposed the toast "The Institute of Metals and the Non-Ferrous Metal Industries." The President of the Institute, Mr. G. L. Bailey, replied. "The Guests" was proposed by Professor H. O'Neill (vice-president), **Sir Harry Melville,** K.C.B., F.R.S. (Secretary to the Committee of the Privy Council for Scientific and Industrial Research), replying.

Presidential Address

RESEARCH in the United Kingdom is organized relatively simply—primarily through the Government on the one hand and private and nationalized industries on the other. U.K. research expenditure in 1955-56 totalled £300 million, or 1·8 per cent of the Gross National Product.

Of the £300 million mentioned above, £225 million came from the Government—£90 million was spent in their own laboratories, £15 million in the universities, and £120 million in the research laboratories of nationalized or private industry.

D.S.I.R. spends some £5 million in its own research stations, which employ about 1,300 qualified scientists. D.S.I.R. also sponsors and supports financially (to the tune of £1·6 million in 1957) the co-operative research associations which until recently have been a unique feature of British research organization, of which there are over forty.

Industry spent £70 million of its own money in its research laboratories, and some £5 million in the research associations. This total of £75 million is half of one per cent of the value of G.N.P. and 0·8 per cent of the value of industrial output, and was 40 per cent of the total amount spent in its own laboratories—the remainder coming from Government contracts, mainly defence.

The distribution of expenditure on research in different sections of industry varies widely. Aircraft is by far the largest, spending in 1956 an amount equal to 35 per cent of its net output on research and development. The average for all other industries is 2 per cent of net output of firms employing more than 100 people—with variations of from 0·1 per cent for the clothing industry to 6·8 per cent for electrical engineering.

The total number of qualified scientists in the U.K. in 1956 was 140,000, of which manufacturing industry employed 55,000. The total number of scientists engaged on research and development was 47,000, and it can be concluded that for those engaged in British industry on research for its own purposes a figure of 15,000 is probably fairly near the truth. The research associations employed 1,500 of these, and thus constituted an important section of industrial research although their combined incomes equal only 2 per cent of the country's gross research expenditure.

United States

In the United States of America, no central body existed for the co-ordination of research like the D.S.I.R. in this country until a few months ago, when a new Federal Council for Science and Technology was set up to promote closer co-operation among Federal agencies in planning their research programmes. There are over 20 departments and agencies of the Federal Government which include estimates for research in their annual budgets. In 1957, 48 per cent of Government work was carried out in industrial laboratories and 17 per cent in non-profit institutions—mainly universities.

The total research expenditure in the U.S.A. in 1956 ($9,000 million) was equivalent to 2·3 per cent of the value of the G.N.P. Of this, 37 per cent ($3·3 billion or 0·85 per cent of the G.N.P.) was spent by industry for research on its own problems. The independent research institutes, such as Mellon, Battelle, and Armour, accounted in 1952 for only 2 per cent of the total research expenditure of the U.S.A. About half of this was provided by Government and the bulk of the remainder by industry for specific projects, the results of which are confidential to the sponsor.

Out of 750,000 scientists in America, the number employed in industry in 1954 was 550,000; of these, 157,000 were engaged in research. About 100,000 of these were employed by U.S. industry on its own problems—about three times as many as were so engaged in this country in proportion to the number of the population (160,000,000 in U.S.A.). An interesting sidelight is that of the total 157,000 scientists engaged in research in the U.S.A., two-thirds are engineers, compared with one-half in the U.K. total.

France

Apart from State laboratories, the French Government exercises a close control over much research through the Minister for Industry and the Minister for Education, who also controls the National Centre of Scientific Research (C.N.R.S.). This organization covers natural, medical and "humanistic" sciences, and employs some 2,500 scientists in some 15 large laboratories and a number of smaller ones.

A most interesting development is the Corporate Research Centres set up and financed by branches of industry to serve the trade concerned.

These are financed mainly by statutory levies, which are said to be paid by over 90 per cent of industry. The Foundry Centre (C.T.I.F.) is financed by a levy on turnover added to the invoice for castings, and the Ironworks

Research Institute (I.R.S.I.D.) by a sales tax on ordinary steel.

The Foundry Centre has an income from a levy of approximately £500,000 per annum, which is equivalent to about £5 per annum for every worker employed in the industry.

This Centre probably devotes less than half its resources to research, the main work of its central and nine regional laboratories being in the provision of routine analytical and testing facilities for the entire French foundry industry.

France's total research expenditure amounts to 0·6 per cent of the G.N.P., excluding the universities. Of this amount, industry is said to contribute only about 12 per cent, but perhaps the expenditure on the Centres Techniques should be added to this.

There seem to be about 150,000 scientists engaged in French industry —much the same proportion as in the U.K. — but further breakdown is difficult.

The professional research organizations, such as the Centres Techniques, over 40 in number, have staffs totalling over 3,000.

Germany

In Germany, there are the Federal Government laboratories, such as the Physical Technical Federal Institute, and also grants are given to a large number of institutions. The Land governments make some financial contribution to the Max Planck Society for the Promotion of Science. After the War 35 research institutes of the K.W.I. were re-organized in Western Germany and supported by the 11 Länder which jointly finance the Max Planck Society. Much of the work done in these Max Planck Institutes is financed by industry.

Two other organizations play a part on a national scale, the Forschungsgemeinschaft, and the Stifterverband.

The first of these receives funds from Government and from subscribers which are utilized to support individuals working on projects which are beyond their own financial capacity. The second raises money from trade associations and private firms and uses this to finance projects of fundamental or applied nature.

An interesting recent development is co-operative research associations similar in principle to those which have hitherto only existed in the U.K. There are now nearly 40 of these associations but they have rather more restricted scope. For instance, in the metallurgical field there are six such associations dealing respectively with sheet metal, iron founding, drop forging, casting, hardness and heat-treatment, wire drawing and cold rolling.

German industry's research expenditure in these various ways amounted in 1956 to over DM.800 million, about 0·45 per cent of the G.N.P. The Länder, the Federal, Land and Municipal Governments, probably spend another DM.650 million bringing the whole research expenditure to over 0·8 per cent of the G.N.P.

Holland

Holland is of special interest for the two Government created organizations which look after research—the Organization for Pure Science (ZWO) grants fellowships and subsidises university research while the Central National Organization for Applied Scientific Research (T.N.O.) is responsible for ensuring that applied research serves the public need. T.N.O., which is governed half by representatives of the scientific world and half by representatives of industry, runs about 40 research institutes including one devoted to Metals and one to Corrosion and supports suitable research projects elsewhere. These institutes are financed in part by direct Government grants, which are usually ear-marked for basic researches and mainly by industrial contributions. These can be used by the Institutes for co-operative programmes or for a collection of individually sponsored projects, or both.

Holland has a particularly difficult situation in that 162,000 of its 172,000 firms employ less than 10 people and only 94 firms employ more than 1,000.

Scandinavia

The Royal Norwegian Council for Scientific and Industrial Research operate a number of Research Institutes such as Atomic Energy, Seaweed, Building and a Central Institute for Industrial Research, modelled to some extent on the American sponsored institutes, while other similar Councils deal with agriculture and humanistic and medical sciences.

In Sweden the learned societies headed by the Royal Swedish Academy of Science, supported partly by the State and partly from private funds, to some extent initiate and co-ordinate research and publish results.

Research in the universities and institutes of technology, is financed mainly by Research Councils and State Agencies, and partly by industry, but there are also a number of research institutes operating in particular fields which are mainly financed by industry. The Metallografiska Institutet operates in the general (largely ferrous) metallurgical field from Stockholm.

The Swedish Iron Masters' Association, organises research on a considerable scale. The industry provides the funds, Jernkontoret organises a number of research committees and the work is placed in industrial laboratories, works departments and particularly in The Metallografiska Institutet and the various departments of the Royal Institute of Technology in Stockholm.

Denmark relies heavily on universities and on the institutions through which the Academy of the Technical Sciences works. Some twelve such organizations work in fields of technology—the Danish Laboratory for Welding being an example—and most of the working expenses are met by industry.

U.S.S.R.

Lack of sufficient facts from Russia make a statistical comparison with Western Europe and America rather difficult. Most of the money comes as an appropriation in the State Budget, with another 20 per cent or so directly from industry.

Information suggests that in 1954 there were 700,000 qualified scientists in Russia apart from agriculture of whom about 100,000 were employed in research and development.

Russian organization aims to prepare a scientist highly qualified in a specialist field. The normal course of training is about 5½ years which includes something like 3 years of specialization. In the metallurgical field, specialization of a ferrous metallurgist might be restricted to the blast furnace or to open hearth metallurgy.

The rate at which people trained in this way are turned out is quite striking. In 1954 70,000 scientists, excluding agriculture and medicine, successfully completed a 5½ year course of training. These compare with 36,000 in the U.S.A. and 11,000 in the U.K. These figures must not be taken as strictly comparable because of differences in standards and qualifications.

Research in Russia is carried out mainly in large centralized research laboratories such as those connected with the Academy of Sciences and more particularly the industrial laboratories set up to study the problems of the country and industry as a whole.

Costs of Research

Research cannot be done cheaply and the very advantages of co-operative research organizations in this country in giving people access to a lot of information for a small sum have, to some extent, confused the issue and have led people to expect humming birds for ninepence.

How much money should industry spend on research? The Federation of British Industries has expressed the view that industrial firms should spend on research from 1-2 per cent of turnover. The differences in research expenditure in this country and in America are quite striking if considered only on the ratio of research expenditure to gross output or sales. Detailed comparison is not possible because the division of Government expenditure between industries is not known but the gross expenditure of industry in the U.S.A. on research and development is 1·7 per cent of sales value compared with 1·1 in the U.K. and of the 1·7 per cent, U.S. industry contributed 63 per cent while U.K. industry was responsible for 40 per cent of the British expenditure.

Technical Session

Continuous Rod and Strip Casting

FOR the first of the Technical Sessions of the Institute of Metals Spring Meeting, held during the afternoon of Tuesday, April 14, the President, **Mr. G. L. Bailey**, C.B.E., took the chair.

At this session a discussion on "Fatigue" took place.

With **Professor H. Ford,** vice-president and chairman of the Metallurgical Engineering Group, presiding, a further technical session took place on Wednesday, April 15, the following Papers being presented: "Equipment and Practice for Continuous Casting and Rolling by the Properzi Process," by James B. Russell and Frank R. Nichols; and "The Hazelett and Rotary Strip-Casting Machines for the Continuous Casting of Aluminium," by R. D. Hamer.

Abstracts of the Papers appear on this page, and a report of the discussion follows.

DISCUSSION

J. B. Russell said that one advantage of the Properzi process was that the purchaser could set up furnace equipment to suit his initial output requirements and then add to the furnace capacity as required. The small operator did not have to stand the burden of needless capital investment and overheads during the initial period. Customers were advised to provide furnace equipment to supply the metal at a rate of at least 4,000 lb/hr. Particularly the melting furnace thus had to be large, bearing in mind the usual run of 40-50 lb/hr/ft^2 of hearth area. Allowance must be made for transferring and holding the metal. The latest type of furnace, mentioned in the Paper, could lead to a considerable saving in space and capital investment.

After describing the process, he said that metal temperatures should not be allowed to exceed 760°C during melting as hydrogen pick-up increased rapidly above this temperature and melting losses might become unnecessarily high. Furnace atmospheres should be maintained slightly oxidizing to minimize hydrogen pick-up. Metal should be transferred to the holding furnace with the minimum of turbulence preferably at a temperature not above 732°C. The holding temperature would generally be 5-9° above the desired ladle temperature. If there were any doubt about metal quality, the metal should be checked for gas content.

After indicating advantages and disadvantages of the method, he said it was possible that in the not-too-distant future there might be a change in the design of the casting wheel.

He produced to the meeting a new type of conductor product developed jointly by Aluminium Laboratories Ltd., the Northern Aluminium Co. and Stirling Cables Ltd. It was an entirely new type of cable construction, consisting of three members at angles of 120°. These cables were being made in several ranges of current carrying capacity and made specific use of the advantage of aluminium. The aluminium conductors used were soft and inherently very flexible and the use of a solid sector made it possible to achieve a higher conductivity level in the aluminium than would be possible in drawn and shaped conductors. For the same aluminium composition the solid sector conductor would have a minimum conductivity of 62·5 per cent I.A.C.S. and a normal conductivity around 63 per cent instead of the 61 per cent minimum for drawn wire. There was also a considerable space saving. As a result, in popular sizes of the cable and at current prices the finished cable would be about 40 per cent cheaper than copper cable of similar design, even if such a cable could be made. Copper work-hardened very rapidly, whereas aluminium relatively did not. The Properzi machine was clearly adaptable to the manufacture of these conductors by substituting rollers of special shape for those normally used to produce round rod.

R. D. Hamer described both the Hazelett and rotary strip-casting machines and added that after the Paper had been

Equipment and Practice for Continuous-Casting and Rolling by the Properzi Process

By J. B. RUSSELL and F. R. NICHOLS

IN recent years the Properzi continuous-casting and rolling process has been improved appreciably. The cross-sectional area of the casting has been increased from 1·42 to 1·76 in^2, with corresponding changes in design, strength and capacity of the rolling mill. These factors, combined with improvements in operating techniques and the ease with which the equipment lends itself to preventive maintenance, have led to significant advances in the quality and economics of production of redraw rod, from which aluminium electrical conductor (EC) wire is drawn. Although most Properzi equipment is used for the production of EC aluminium rod, the process has gained a strong foothold in the zinc industry, and results to date of casting aluminium alloys, other than EC metal, have been most encouraging.

Finishing speed and temperature of the redraw rod, as it leaves the rolling mill, are such that it is possible to provide 100 per cent inspection by means of an eddy-current inspection unit.

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The Hazelett and Rotary Strip-Casting Machines for Continuous Casting of Aluminium

By R. D. HAMER, B.Sc.

BOTH the Hazelett and the RSC machines produce consistent metallurgically sound cast slab of commercial-purity aluminium. With the RSC machine, experience indicates that considerably more than 50 tons of 0·75 × 8 in. strip (hot rolled to 0·375 × 8 in.) may be cast before belt distortion causes defects in the strip. The Hazelett belts are not subject to serious distortion and they can be re-treated. The RSC belts are not expensive, and with further development of the equipment the belt is likely to become shorter and more durable.

Assessment to date indicates that a Hazelett slab can be rolled into sheet that exhibits satisfactory mechanical properties and forming characteristics. RSC strip is generally well suited for impact-extrusion slugs. When rolled to thin-gauge commercial-purity aluminium strip, its properties, including surface appearance, closely resemble similar products produced by conventional methods, except that, from the viewpoint of appearance, RSC material does not have the same good anodizing properties as strip produced from scalped sheet ingots. It is possible that by a continuous chemical pretreatment, the anodizing quality of a strip could be improved.

The Hazelett process has the advantage that the slab is cast flat, and the likelihood of cracks appearing in the cast slab (particularly with alloys) is not as great as in the case of the RSC strip. At present, Hazelett slab has been cast 36 in. wide and no serious difficulty is expected in casting slab up to 60 in. wide. It is not known whether RSC strip wider than 10 in. can be produced.

The Hazelett process appears to have promise for the production of large tonnages of wide aluminium strip. For lesser tonnages of narrow strip, and probably for only a limited range of alloys, the RSC technique may be adequate.

RSC strip can be fed directly to hot- and cold-rolling mills successively, and on through slug-blanking equipment. Similarly, slitting, roll forming, and automatic strip-welding equipment could be installed in line with the casting and rolling machines. In the case of Hazelett slab, cutting to suitable lengths before hot rolling appears to be indicated, whereafter the efficient introduction of a variety of further fabricating operations is conceivable.

(*J. Inst. Met.* 1959. **87**, 219).

submitted they had decided to begin to produce slab 12 in. wide by $\frac{1}{4}$ in. thick.

In the rotary strip-casting process the cooling and metal distribution techniques were all important. It had been their wish to produce a machine and a process which would be as simple as possible so that there would be no difficulty in operating continuously. Because of this, the process in its present form and for 12 in. wide strip was suited for the production of only pure aluminium and alloys which were not particularly hot-short sensitive. He believed that the range for 12 in. wide materials could be increased, however, and in any case the casting of most alloys of interest was practicable for narrower widths. The criterion for satisfactory casting was that they must be able to cast continuously on a one-shift basis for a week without any cracks appearing.

Dr. G E. A. Bramley (Aluminium Wire and Cable Co. Ltd., Port Tennant, Swansea) said it was interesting to recall that the Properzi process had its origins in connection with the lead-shot industry. Properzi had developed the first version of his process to cast continuously a small, approximately triangular section of lead which was then rolled down to give a round wire. This, in turn, was fed into a machine which stamped out the shot from the wire. After barrelling, to remove the flash, the shot was so truly spherical that its scatter when discharged from a cartridge was appreciably reduced.

From that early continuous lead casting machine the process had been developed through zinc casting until, about 1948, Properzi had turned his attention to the continuous process for casting and rolling aluminium rod.

The authors, in dealing with metal preparation, referred to the importance of prevention of contamination by hydrogen and oxides. These problems were present also in the casting of billets for rolling on conventional mills and, indeed, the degree to which wirebars were free from entrapped oxides in a very large measure dictated the freedom from breakages experienced in drawing to fine wire. Breakages even in the thicker electrical conductor wires, due to such inclusions in the wirebar, were by no means unknown. It had always appeared to him, however, that the operator who was concerned only with the casting of a billet or wirebar had a better chance of avoiding oxide contamination than had his counterpart on the Properzi machine, who would often be found not only maintaining the somewhat delicate balance of cooling on the casting process, but also the balance of output between the two units.

Some operators of the Properzi process for aluminium made use of boron additions in their own melting operations, as distinct from the use of boron-treated pig mentioned by the authors. Unless suitable precautions were taken, this, too, could give rise to inclusions of the insoluble metallo-boron complexes which could be formed by this treatment.

The authors mentioned gas, oil and both electric resistance and induction as possible means of heating furnaces supplying metal to a Properzi unit. It would be interesting to have the authors' views on which method, from the point of view of freedom from contamination, flexibility and maintenance, they would favour, other things being equal.

Although alloys were being produced, electrical purity aluminium was still the greater tonnage of materials produced by the Properzi method, and with electrical

J. B. Russell

F. R. Nichols

R. D. Hamer

purity aluminium, pick-up of impurities from the furnace lining which would affect the conductivity of the resulting metal was always to be guarded against in this process which, unless operated at a reduction works, necessitated the remelting of the virgin metal. Unless Properzi operators resorted to more expensive high-purity alumina linings for their furnaces, they must demand a higher level of purity for their pig supplies than that normally used for the manufacture of rod by conventional methods where a remelting operation was not involved.

The progress which had taken place over the last ten years in the design of the casting machine and the rolling mill in the Properzi process was remarkable. His company had operated a Type 3A machine in 1949 but, compared with the Type 6 machines described in the Papers, it could be regarded almost as a prototype. While the principles of the process had remained unaltered, the rolling mill was now of rugged construction much more suited to the rigours of continuous operation, and the casting machine had been improved considerably from the point of view of both output and operational control.

The most important development had been the increase in area of the cast section, which was well illustrated in Fig. 7 of the Paper by Russell and Nichols. Naturally, this had increased output, but it had also had the desirable effect of making the tip of the pouring spout more visible to the operator.

Despite this improvement, the authors had justifiably pointed out that proper positioning of the spout in the groove was of paramount importance in successful casting. This remark, coupled with his own experience, led him to believe that variability in the quality of the cast section was still experienced in the process. Unfortunately, the authors gave no indication in the Paper of the amount of process scrap experienced in normal operation. It would be interesting to hear from users of the process what percentage of total section cast had to be discarded because of casting defects.

The authors mentioned that belts became slightly distorted during use, and under "Metallurgical Considerations" they mentioned eutectic exudation on the top side of the casting which was in contact with the steel belt. Distortion of the steel belt—a bowing in a transverse direction so that the side in contact with the cast section tended to become concave—had been a problem experienced with the much narrower belt on their own Type 3A machine. It had been noticed that as the distortion became progressively worse with the age of the belt, so did the amount of eutectic exudation on the side of the casting in contact with the belt. It had appeared to them that the belt was held essentially flat in the vicinity of the clamp-down roll *F*, shown in Fig. 2—in other words, at the point of initial freezing. As the belt and casting moved away from the vicinity of this clamp-down roll, the belt again assumed its natural bowing, thus moving away from the cast section. It, therefore, appeared that the effect of belt distortion could be minimized and exudation diminished if a series of clamp-down rolls, instead of only one, could be applied to the belt in the vicinity of the solidification zone.

It was of interest to note the authors' remarks about the different types of flood coolants in use by various operators, all of whom, in the main, were presumably producing only electrical purity aluminium. The difficulties introduced in subsequent wire-drawing operations by the use of oil-stained rod were well known, yet, in spite of this, although some operators were successfully using soluble oil as a coolant, others were stated still to be using mineral oils. Did this imply a wide variety of operating conditions between different operators? If this were so, since the pass design was standardized one could only infer that the rolling temperature varied appreciably, perhaps due to differing degrees of cooling on the casting machine.

That there were variations in the cooling conditions adopted on the casting machine by different operators was confirmed by the authors' remarks that the grain size of Properzi-cast electrical purity aluminium varied from medium to columnar. It had appeared to him, in his earlier experience of the process, that two extremes of technique were being developed. In the first, the cast section was cooled relatively slowly and taken from the casting wheel at a relatively high temperature in order that the amount of cold work during rolling should be minimized. This resulted normally in a cast section with a good surface quality but with a coarse columnar structure. Rod rolled from such a section was not given a low temperature heat-treatment before drawing. The other technique was one whereby the cast section was cooled more drastically, giving rise to an equiaxial structure. In this case, however, since the surface quality did not appear quite as good, and rolling was carried out at a lower temperature, it was usual to give the rod a low-temperature heat-treatment before drawing in order to achieve the necessary compromise between mechanical and electrical properties in the finished wire.

As the authors said, variation of grain size and shape were not unique to the Properzi process. Two slides illustrated this point. The first was a section of a casting from normal production on a Type 6 machine, in which the columnar grain structure was clearly evident. The second was a section of wire approximately 0·1 in. diameter, taken from an aluminium overhead conductor of

European manufacture. The original cast structure of the Properzi section which had continued through to the final wire despite the considerable amount of work subsequently applied in rolling and drawing, could be recognized. Such a structure would never exist in normal production by conventional hot-rolling methods.

Had the authors any evidence to show that the fatigue resistance, and particularly the torsional fatigue resistance, of conductors manufactured from such wire was such that they would give the same satisfactory performance as conductors manufactured from conventionally rolled rod—in other words, as conductors whose performance had been proved by many years of service experience?

It was true that not all Properzi-produced wire showed such a structure, but this variation, which definitely existed, appeared to be an aspect of the process on which more work should be done. There were many cases in the field of general wire applications other than conductors where this type of coarse structure would be unacceptable.

Russell and Nichols referred to a smaller loss in conductivity when drawing Properzi rod to hard temper wire than obtained when conventional rod was similarly drawn. They stated that the loss for Properzi rod was 0·3 per cent I.A.C.S., compared with a loss of 0·5 per cent for conventional rod. This was surely explained by the fact that the amount of cold work initially in the Properzi rod was greater than that in the conventional rod, and its conductivity was, therefore, lower to start with. Conductivity of aluminium approached a limiting value asymptotically as the degree of cold work increased.

They said that Properzi rod conductivities ranged from 61·4 per cent to 61·8 per cent. Their stated loss of 0·3 per cent in drawing to hard temper wire, therefore, gave a conductivity range of 61·1 per cent to 61·5 per cent I.A.C.S. for the wire. It was the conductivity of the finished wire which was important. Compared with these figures, the average level of conductivity of hard temper wire drawn from conventional hot-rolled rod was around 62·5 per cent. A figure of this order would be quite normal for metal of the typical composition given by the authors for wire produced from rod rolled on a conventional mill.

From these figures, it therefore appeared that for the same order of metal purity the conventional rod mill would enable aluminium conductor wire to be produced with more than 1 per cent higher conductivity than the Properzi process. This was not surprising in view of the known beneficial effect on conductivity of the billet reheating operation prior to rolling on the conventional mill.

The authors mentioned that aluminium conductor wire could be produced from Properzi rod to meet all the requirements of A.S.T.M. specifications and that, in addition, Properzi rod had been supplied commercially to a minimum conductivity of 62 per cent, presumably while still meeting the A.S.T.M. tensile requirements.

Until recently the Canadian conductor specification, which was much used as an international basis for export business, had the same minimum tensile and conductivity requirements as the A.S.T.M. specification. The minimum tensile requirements of the Canadian specification had recently been raised above the A.S.T.M. level.

Since the authors said that a metal purity as high as 99·74 per cent, coupled with heat-treatment of the rod, was required to achieve 62 per cent conductivity and the A.S.T.M. tensile requirements, was it, in their opinion, practicable to achieve by means of a Properzi unit the still higher tensile requirements of the Canadian specification and at the same time maintain a minimum wire conductivity of 62 per cent? The Canadian specification requirements were 61 per cent, as for A.S.T.M., so that a Properzi producer could presumably achieve bare specification requirements without undue difficulty, but in these days of competition would it be possible for a producer with a Properzi unit to offer, if he felt it commercially advantageous to do so, the 62 per cent conductivity of the American market together with the higher tensile of the Canadian specification? Did the authors, or any other users of the Properzi process, consider that it could be achieved with that process?

P. H. Greer (Unidaire Ltd., Dublin) said that their equipment had been commissioned in the summer of 1955. In the past year the casting wheel had been modified to the 6B dimensions mentioned in the Paper. The furnaces comprised one 10-ton oil-fired remelting furnace using 200 sec. oil and having 4,000 lb/hr. melting capacity. There were two 5-ton electric resistance holding furnaces, which were also tilting. All furnaces had 99 per cent alumina linings below the metal level. Russell had mentioned the use of 90 per cent alumina lining for E.C. metal. Could an even lower grade of lining be used if the furnace were treated with cryolite? This would save cost in lining replacement.

Russell had mentioned fluxing in the holding furnace; he, the speaker, had had trouble as a result of corrosion of the resistance elements.

The pouring spout first used was that illustrated in the Paper, but experience had shown a very variable life from these spouts. Wrought iron, cast iron and Meehanite had been used, but no one had been able to predict the length of life. They had come to the conclusion that, owing to the bend in the spout, considerable turbulence occurred in the metal and erosion of the coating took place. The coating broke down quickly and the spout disintegrated, and parts of the spout were found in the cast metal. That had been eradicated completely by a re-design of the holding pot and spout arrangement. The holding pot had been extended over the wheel in such a way that, instead of having a dog's leg spout, there was a straight spout coming out of the bottom corner of the holding pot and projecting straight into the casting. Spout life was now about four or five times as long as that previously experienced.

There were some other advantages from the straight spout. It was easier to make and easier to maintain, and the control valve mechanism was brought out over the wheels. There was a straight plug-type valve operating at the top end of the spout, which was direct-acting and sensitive.

Russell had mentioned a life of four to five weeks for the holding pot. This was quite different from the speaker's experience; in no case had the life been less than six months.

Turning to the discussion of the casting wheel and cooling, he said that at one time they had had trouble from using well water not as soft as mains water. The water passages inside the wheel were very small—about 2 mm. diameter—and if only a few of these were blocked there was uneven cooling and trouble. The solution found had been to depart completely from the original cooling method. They had taken the side off and had sprays internally, directly on to the inside of the periphery. That was completely accessible and trouble free. It was unnecessary to flush out with acid or descaling materials, and the sprays were individually adjustable. This was a change from Russell's method, which appeared to have retained the original Properzi system but added to it. The speaker had found no advantage in retaining the original. He was working only with E.C. rods, but he imagined that the

The President and Mrs. G. L. Bailey at the reception which preceded the annual banquet of the Institute of Metals

flexibility of the system would make it suitable for alloy castings should they be required. He had recently tried a cast iron mould with satisfactory results, but had not yet put such a wheel into everyday use.

The authors had mentioned casting speed and tensile strength, but it should be remembered that the varied tensile strength had been obtained by varying the casting rate, which was not economic. If a higher rate were possible, then it was a pity to slow it down to obtain material of a required tensile strength.

He had installed secondary cooling just before the bar entered the mill. This enabled them to run at higher speeds and to get any tensile strength they liked. For example, before installing this equipment they ran at an average of about 3,400 lb/hr., but with the secondary cooling they were running at 4,700 lb/hr., which was the maximum speed of the mill because of drive considerations.

Russell had mentioned the development by Cie Pechiney of the immersed spout technique. He, himself, had found this an improvement.

The equipment was readily maintained, he agreed, and generally had stood up to use very well. There had been some trouble with failure of the oil seals on the roll bearings, and they looked forward to a solution of this problem.

Russell had said that in corrosion the finished material compared favourably with conventional rods. Although he had had no trouble of this kind, he asked Russell to enlarge on the phrase "compared favourably."

A tightly wound coil was shown in Fig. 18 of the Paper. He had had great trouble with this type of tightly wound coil. Before they had their own machine they imported their rods, and they found condensation occurring in the interstices in the mould, which made the material wet. It would then not take lubrication in the wire drawing operation. With 200 tons of that material it seemed impossible to dry it. In some cases it had been necessary to re-melt and put it through the Properzi plant in order to eradicate the trouble. As a result, they used a loosely wound coil.

Regarding the question of scrap in the casting process. At present, on one shift a day, probably two lengths of 20 ft. of bar were discarded at the beginning and an odd length of, perhaps, 10-15 ft. at the end of the run, but unless there were an unusual occurrence, such as a belt breakdown—which did not often occur—there was no other scrap. The wire drawing scrap went into the mill.

W. J. Bannister (British Insulated Callender's Cables Ltd.) said they had conducted some research on aluminium rods, produced by the Properzi system, and the Tessman system of casting horizontal bar and eventually rolling it through a continuous mill, and the extrusion method. Results showed that the Tessman rod, heat-treated, gave a conductivity of 62·28 per cent; Properzi, heat-treated, 61·9 per cent; extruded rod, 62·05 per cent; wirebar, 62·51 to 62·72 per cent. He had seen some figures for modern bar recently at 63 per cent, which was a further threat to the Properzi process.

He had carried out some empirical work, and had found that if they took E.C. wire and water quenched from various temperatures, the conductivity dropped with the quenching temperatures. At 400°C. water quenching they lost 0·3 per cent I.A.C.S.; at 500°C. 0·65 per cent; at 600°C. 2·2 per cent. This had been followed with some tests with Properzi rod. They had remelted it and made wirebars out of it. This was hardly calculated to improve the quality of the metal. After rolling, the conductivity of the wire from the original Unidaire rod had been 60·1 per cent, whereas with hot rolled rod it had been 61·15 per cent.

He had been assured that it was essential to have large capacity furnaces for metallurgical reasons, presumably for getting rid of the gas. A time of 52-90 min. had been quoted, yet in the Paper they assumed that the size of the furnace depended purely on operational necessity rather than metallurgical necessity.

In 1953, Properzi had made a very bold attempt to cast copper. It certainly had the shape but seemed to be carrying more oxide than permitted. What steps were being taken on the aluminium side to deal with the conductivity and tensile problems, and what were the first steps in the production of high conductivity copper. By extruding normal E.C. billets, 62 per cent had been achieved with the Canadian specification, but this was on the borderline and was not dependable.

He had been interested in the cable shown by Russell because they had been trying something similar. What was the metal which gave the figure of 63 per cent?

J. B. Russell replied that it was fully annealed.

G. Littlewood (B.I.S.R.A. Continuous Casting Team) said that whereas the non-ferrous metals industry talked of lb/hr., in the steel industry they talked of tons/hr. At Sheffield, they had cast steel in three square sections at 12 ft/min., which compared very favourably with the speed of 20 ft/min. of the much smaller section mentioned in the Paper, bearing in mind that their moulds were only 20 in. in length. On the other hand, the Papers suggested that the authors were achieving a much higher rate of heat transfer.

The Properzi process seemed to be intended to work against nature. The casting was uphill and solidification was almost instantaneous across the cross-section, whereas in the case of the rotary strip-casting machine it was inclined slightly downwards.

F. R. Nichols said that the difference between the first Properzi machine, with an output of 800 lb/hr., and the figure of 4,700 lb/hr. quoted by Greer was remarkable. The problems raised by the 62 per cent conductivity requirement were being worked on, and two machines had been sold bearing that situation in mind. It was interesting to know that not only were the cable makers using the equipment, but that in the aluminium group of companies throughout the world, four were operating Properzi units.

F. A. Green (Glacier Metal Co. Ltd., Kilmarnock), speaking on Hamer's Paper, said that the discussion had concentrated on making bigger casts. Could he have some comments on making materials smaller and better? What was the minimum thickness which could be cast from pure aluminium? Would the Hazelett process be the better of the two described for this purpose? Could the author state what was the surface quality obtained? Was the surface produced inferior or superior to that which would be obtained from aluminium billets cast in mould?

M. D. Lewis (Aluminium Laboratories Ltd., Banbury) said that the system of metal preparation using a large melting furnace—about 10 tons—and two holding furnaces—about 5 tons each—had been widely adopted but he felt that there could be little justification for this costly and inefficient lay-out. It was clear that the furnace arrangement was based on the very doubtful procedures of maintaining a furnace heat, low melting rates and extended holding times which were expected to remove oxide and gas. Modern furnace equipment could produce high quality E.C. metal from a low cost, high efficiency and compact lay-out. Russell had indicated in his introduction that some work was taking place in the testing of these furnaces.

Induction furnaces appeared to be most undesirable for the Properzi process as by their nature there was no opportunity for separation of the oxide. It would be of value if Russell could state how this liability was overcome in plants using induction furnace melting.

The use of 90 per cent alumina bricks

A group at the Institute of Metals banquet: Miss L. J. Scratchley, Mr. D. J. Greve, Mrs. B. Trehearne, Mr. and Mrs. P. J. Scratchley

in the furnace lining was expensive. Surely that had become unnecessary now that brick glazing techniques could allow normal firebricks to be used without any possibility of melt contamination and with considerable improvement in lining life.

As had been revealed in the discussion, the use of cast iron spouts in the casting machine could be unsatisfactory because of rapid blockage and failure without any indication to the operator. If the spout were not red hot before any metal began to pass through it, and if it were not maintained hot, there was serious trouble with metal flow.

Greer had indicated that the complex form of the wheel construction was not essential. In various experiments over the past few years it had been confirmed that the complicated wheel could be replaced by a single copper or steel ring containing the casting groove. This led to a significant reduction in cost. The whole wheel assembly became much simpler and the operation was considerably improved.

In addition, as Greer had indicated, the water-cooling system could be replaced by a ring of water jets giving a fine spray curtain. There was some indication that the heat transfer rates were considerably improved in this way.

The sooty flame method of coating the steel belt was often unreliable in operation. He had not yet seen a steel belt which had a uniform soot coating. What were the reasons for using this coating in preference to a more uniform coating of colloidal graphite?

A factor of extreme importance in the operation of a Properzi casting machine was the method of control. This was not made clear in the Paper, but Russell, in his introduction, had stated that the Nichols Wire machine used constant speed, and it would be useful to have his comments on the value of constant speed control versus metal stream flow control.

Operation of the casting machine as outlined in the Paper covered the machine as normally supplied. He felt that this procedure could be greatly improved by removing many of the more troublesome features. In particular, he felt that the holding basin or reservoir could usefully be made up of insulating material, thereby cutting out the extensive heating of this unit, and the cost of the very large quantity of gas used for this purpose. It would also be more comfortable for the operator, who had to sit for long periods fairly near to this heated unit.

The spout arrangement could usefully be replaced by an open launder of insulating material. This naturally cut out the immersed stream but vastly increased the visibility of the pot and therefore the general control of the machine. There did not appear to be any indication that not using the immersed spout in this way could lead to any diminution of quality.

Much could be done to modify and therefore increase the efficiency of the cooling water system. In this way it would be possible to control the belt distortion and thereby reduce the occurrence of exudation on the bar face.

The impact of the Properzi process upon wire rod production had been great in the last few years and there was no doubt that an extension of some of the modified techniques and possibly the adoption of plant or slight equipment modifications from somewhat similar processes would add further to the value of the method.

A. L. Pendrey (John Dale Ltd., London Colney) asked what was the underlying metallurgical factor for the depressing loss of conductivity. Was it silicon in solution? If so, to what extent could this be offset by adding iron to get the correct metallurgical structure?

To some extent the conductivity was governed by surface conditions. On this continuous cast aluminium, how did the surface differ from the underlying metal? Was it enriched in oxide? Was it misused in the hot rolled state? Would the effect on the surface account for the 62:61 ratio?

The Properzi process used a copper mould. Could details be given of the use of a copper mould with the rotary strip-casting method? Steel and cast iron suffered from crazing, which reduced mould life. Copper, by its very nature, might be of assistance.

To what extent could there be automatic reading of the temperature of the strip from the casting wheel? Had further progress been made in obtaining direct reading of this temperature from the casting wheel?

It was surprising to learn that in this process the hot roll pattern was removed in the finishing process. Despite the splendid finish shown, he felt that anything done in the hot rolling stage would leave a pattern in the final product.

One weakness of the machine was the life of the belt. Was any improvement possible through a continuously made belt? There was belt distortion through having molten metal on one side and cold water on the other. Could there be a bimetallic belt, with steel on one side and the requisite thickness of aluminium on the other?

(To be concluded)

Among those attending the banquet were Mr. and Mrs. L. V. Chilton and Mr. and Mrs. R. Mercer

Men and Metals

Works manager at the Edmonton works of British Oxygen Gases Limited, **Mr. W. H. Pearse,** B.Sc., A.M.I.Mech.E., has left England to deliver a lecture at the proceedings of the Convention of the Canadian Institute of Welding. The subject of Mr. Pearse's lecture is "New Developments in Automatic Flame Cutting."

In order to introduce the Fusarc/CO_2 automatic welding process to Canada, **Mr. D. B. Tait,** manager of the Welding Applications Department of Quasi-Arc Limited, is visiting Toronto in connection with the demonstration of this process at the National Industrial Production Show by an associated company, British Oxygen Canada Limited. During his stay in Canada, Mr. Tait will also deliver a Paper on "Automatic Welding in the U.K." to the Canadian Welding Society.

A local director of Thos. W. Ward Limited, **Mr. R. Hadfield** has been elected President of The Silica and Moulding Sands Association for the ensuing year. He has been vice-president of the association for the past two years. Mr. Hadfield also represents his company on the Councils of the Pig Iron Merchants' Association and the Foundry Coke Merchants' Association.

At the first annual general meeting of the Association of Light Alloy Refiners and Smelters Limited, **Mr. R. Hahn** (B.K.L. Alloys Limited) was appointed chairman, and **Dr. J. Jakobi** (International Alloys Limited) was appointed vice-chairman for the ensuing year. The Council of Management for the same period consists of the chairman, the vice-chairman, and the following members: **Mr. F. Farenden** (The Eyre Smelting Company Limited), **Mr. W. W. Kee** (Enfield Rolling Mills (Aluminium) Limited), **Mr. E. W. Nicholls** (The Wolverhampton Metal Company Ltd.) and **Mr. P. Ward** (John Dale Limited).

Chairman of the Board of Governors of the National Foundry College and a past-president of the Joint Iron Council, **Sir Frederick Scopes** is to open the Foundry Exhibition at Bingley Hall, Birmingham, on May 21. Sir Frederick was knighted in 1954, and since 1957 has been chairman of the Stanton Ironworks Company Limited.

Technical Session

Vacuum Metallurgy

AT the afternoon session on Wednesday, April 15, the four Papers were introduced by **Dr. L. Northcott**, F.R.I.C., F.I.M. (Rapporteur). They were: "Arc Melting of Reactive and Refractory Metals," by Dr. Maurice Cook and E. Swainson; "The Vacuum Casting of Uranium," by J. Stephenson; "Experiences in Vacuum Melting Some Special Metals and Alloys," by W. F. Randall and Dr. H. H. Scholefield; "Selection of Pumping Systems for Vacuum Metallurgical Processes," by A. S. D. Barrett and M. E. Harper.

Abstracts of these four Papers appear below, and a report of the ensuing discussion follows.

Arc Melting of Reactive and Refractory Metals

By MAURICE COOK, C.B.E., D.Sc., Ph.D., F.I.M. and E. SWAINSON, B.Met.

TWO features are characteristic of the arc furnaces which have been developed to melt reactive and refractory metals such as titanium, zirconium, molybdenum and niobium, all of which, in the molten state, attack conventional refractory materials and react rapidly with atmospheric gases. These features are:—the use of a crucible cooled to a temperature significantly below that of the molten metal it contains, and provision for vacuum or inert-atmosphere melting. The furnaces fall into three main categories:—(i) non-pouring, non-consumable-electrode furnaces; (ii) non-pouring consumable-electrode furnaces; (iii) pouring furnaces. Of these types, furnaces belonging to the second group probably account for over 95 per cent of current industrial production. Copper is now the accepted material from which the crucibles are made, although aluminium and stainless steel have also been employed.

(*J. Inst. Met.* 1959, **87**, 161).

The Vacuum Casting of Uranium

By J. STEPHENSON, B.Met., F.I.M.

THE design of a furnace for melting and casting uranium under vacuum is described, and the experimental work to establish critical points of design and operation is summarized. The furnace is versatile in operation, and a large variety of castings has been made both on a production scale and as single castings. Experience shows that vacuum casting can be both simple and clean, and results in an increase in metal purity

(*J. Inst. Met.* 1959, **87**, 174).

Experiences in Vacuum Melting Some Special Alloys

By W. F. RANDALL, B.Sc., A.R.S.M., M.I.E.E., F.I.M. and H. H. SCHOLEFIELD, Ph.D., B.Met., F.Inst.P., F.I.M.

VACUUM melting of nickel-iron-base alloys of high magnetic permeability of the Mumetal type enabled much closer tolerances on composition to be achieved. Non-metallic inclusions in the cast ingot were almost eliminated. Removal of sulphur and carbon was advantageous, as was also the removal of gases. Absence of refractory oxides in the final alloy (due to the fact that no deoxidants had to be used) assisted the development of high permeabilities. Breakages during drawing of fine wire resistance alloys were eliminated, due to increased ductility and freedom from inclusions of vacuum-melted alloys. Vacuum melting also resulted in markedly superior hot-working characteristics. Complex precision-cast shapes in alloys of the Nimonic and Stellite types, for high-temperature service are being produced by vacuum melting and casting using the "Mercast" process, as well as in simpler copper-base and aluminium-base alloys.

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Selection of Pumping Systems for Vacuum Metallurgical Processes

By A. S. BARRETT, B.Sc., M.I.Mech.E., A.M.I.Chem.E. and M. E. HARPER, Grad. Inst.P.

THE most widely used systems for vacuum metallurgical processes employ singly, or in combination, pumps of four main types:—(i) The oil-sealed rotary pump; (ii) the Rootes blower; (iii) the vapour diffusion pump; (iv) the vapour booster pump. The steam-ejector and water-ring pump are also finding increasing applications. The pressure range for vacuum metallurgical processes is approximately 10 to 10^{-6} torr, although for the majority of industrial applications the lower boundary is 10^{-4} torr (1 torr = 1 mm. Hg pressure). The primary considerations for the selection of a pumping system are dictated by:—the pressure range to be covered; the gas load; and the time cycle desired.

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DISCUSSION

T. M. Kessel (Johnson, Matthey and Co. Ltd., London) said he observed in one of the Papers that mention was made of the coil being coupled so that the bottom section started first, and then the whole coil being brought in afterwards to help the melting. Anyone who had done any vacuum melting had probably experienced the exasperation of standing by a furnace and not being able to do anything because it was crusted over, and there was a bad bridge. Had anyone done any work whereby the process was reversed, in that the top of the coil was energized so that the top charge melted first and came down on to the bottom part, and then the whole coil was energized. In that way the possibility of bridging was reduced.

All the authors mentioned casting under vacuum. Had they done much work with regard to casting under an inert gas, and did they find it helped in getting sounder castings?

P. McK. Knowlson (Vacuum Research (Cambridge) Ltd.) showed some slides illustrating a pumping set recently installed at Cambridge, and referred to in the Paper by Barrett and Harper.

The chief feature of the set was that it was fitted with automatic operation. It was controlled solely by two switches, one of which closed the let-down valve and the other started the water ring in the pump. From then on the whole sequence was automatic.

When the pressure came down to about 40 mm, an air injector was switched into the circuit automatically, the valves being operated by a relay. The process continued to exhaust the chamber to about 15 mm. at which stage the Rootes pumps were automatically switched in. All the valves were automatic.

Vacuum lock was used a great deal in metallurgical processes, but in his view it should be used far more. If one imagined having, instead of one process chamber, three chambers, the first being a loading chamber, the second the process chamber and the third the unloading chamber, it would mean that the process chamber could be kept under vacuum all the time. At present many processes wasted a great deal of time in heating up the furnace element and getting up to the process temperature. If the process chamber could be maintained under vacuum all the time, that delay would be eliminated. It was an industrial application rather than for laboratory use, because it would enable higher through-put. He gained the impression that vacuum was quite often treated as a laboratory tool, and was still treated rather gently. In fact it was an industrial tool and could be used as such on automatic control.

R. Eborall (British Non-Ferrous Metals Research Association) said it was very impressive how large the melting equipment had become. It was probably fair to say that the only limitations on size in the present sort of technique were of an economic nature. Where the material produced was valuable enough, the technique could profitably be used.

Dr. Maurice Cook

E. Swainson

W. F. Randall

H. H. Scholefield

A. S. Barrett

M. E. Harper

Incidentally, in the Paper by Barrett and Harper it was observed that the unit of torr was used which was the same as 1 mm. of mercury. If one were concerned with rates of evaporation it was necessary to convert those units to absolute units, and there was a great deal of confusion. Personally, he would be glad to see all those units scrapped and the absolute unit of millibar as used in meteorology adopted. There seemed to be more scope for the use of air locks in vacuum apparatus for metallurgical purposes generally.

All the applications described were batch processes which tended to be slow. There was a contrast between controlled atmosphere processes, which could easily be made in many cases continuous. Clearly a step in that direction was to use an airlock as a means of getting things in and out of the vacuum. There was probably a fairly long cooling period in all melting methods of the hot crucible type before one could open up the vacuum chamber to the air without having oxidation of residue metal in the crucible and across the furnace.

One way round that had been observed in Randall and Scholefield's Paper in which they had two furnaces which they used alternately.

One assumed that the authors were using de-oxidants. In some applications of vacuum melting—the purification of steel to remove carbon and copper to remove sulphur—oxidation was done deliberately followed by de-oxidation in the case of steel with hydrogen, and in the case of copper with a carbon crucible. There had recently been mention in the literature of the de-oxidation of metals which formed volatile oxides, particularly in arc melting or by electron bombardment, and apparently it was possible to volatilize oxygen, and the metal would volatilize subsequently.

There were other applications which might be important such as removing volatile contaminants. Some of those applications could lend themselves, and in some cases had lent themselves, to continuous operation. For instance, to remove volatile elements one could take the metal in the vacuum chamber through the barometric column, pass it over a weir, expose a great deal of the surface to the evacuated space, and then take out of vacuum again through the barometric column. There might be more application for that kind of technique in purification than in melting, although vacuum melting had a great advantage in that it was possible to avoid contamination. It was not always obvious in vacuum melting that in purifying metal one was not doing it very efficiently, because purification only took place on the surface. Below the surface there was large hydrostatic head and there could be no boiling off of impurities. There was an advantage in using methods in which a stream was exposed to evacuated space.

A. R. Moss (A.R.D.E.) said that comments in the Paper by Cook and Swainson on the effect of current on molten pool depth were interesting. It had been the practice to assume a vague figure, but some time ago it was determined and a series of curves had been produced which were published in the Journal of Less Common Metals, Vol 1. Similarly, with that research the effect current had upon the orientation of the columnar crystals was determined.

Mention was made of the fact that one was liable to obtain inclusions of solid particles using non-consumable electrodes. That effect could also be obtained with consumable electrodes.

Arc length control presented a very difficult problem. As far as he could see the only satisfactory control was purely and simply manual control and visual observation of the melt. One of the reasons for that was related to the arc characteristics. To take a given length of electrode, one would assume that arc striking and arc running voltage for any particular point was the same along the whole length of the electrode, but in fact that could vary greatly. He had plotted differences of up to 7 V. Generally the difference tended to be about 6 or 7 V rather than 1 or 2 V. It was interesting because it might be related to the fact that an electrical arc could exist in two forms—the thermionic emission arc and the field emission arc.

Reference was made to the glow discharge. That phenomenon was of a rather vague nature, and more had to be learned about it. He did not agree that it was a type of displaced arc. The fact that it was not a displaced arc could be proved by the fact that the glow was characterized by fall-off in current density at the cathode. Whereas the current density at the cathode of a true arc was, say, 20,000 amp/cm^2, in a glow discharge it would probably drop down to 400 or 500 amp/cm^2.

As to the question of insensitiveness of arcs in high vacuum, it was necessary to exercise care because the voltage gradient of an arc depended drastically upon the actual vacuum pressure.

It was rather surprising that the authors mentioned an arc length of about $\frac{1}{2}$ in. to $\frac{3}{4}$ in., especially bearing in mind that they seemed to be considering large diameter ingots. A length of $\frac{1}{4}$ in. to $\frac{3}{8}$ in. seemed to be very small, and bearing in mind the fact that they were using magnetic stirring, one would expect the shape of the upper surface to be curved.

H C. Child (Wm. Jessop) expressed some surprise in having seen no mention in the Paper by Barrett and Harper of steam injector pumps, as they seemed to be coming back particularly in the handling of large quantities of gas. They had the advantage of being able to handle dirt and obviously water vapour.

With regard to the furnace described by Cook and Swainson, the power input was at the top flange of the copper crucible. It had been suggested that it would be safer if the power input were at the bottom of the crucible, and if the bottom plate were insulated from the crucible walls.

Vacuum metallurgy was the only way known of melting the reactor elements, but it was disappointing to find that so little mention was made of what was being achieved by vacuum melting special alloys.

Mr. Beckett (Wild-Barfield) speaking, he said, as the representative of the company which was designing and building equipment in this country for the National Research Corporation of America, pointed out that the N.R.C. had for some years made a feature of bringing the mould power into the base of the stool. The mould wall was insulated from the stool, and the theory behind it all was that if one were arcing to an ingot which was sitting on the mould stool, and in solidifying there was shrinkage, the arc would strike to the ingot and not to the mould. It was a good safety feature if it could be achieved. Admittedly there was some doubt as to whether it was worth while, but it was a somewhat negative approach to say "It will not work." The only argument in favour of the method was that there was shrinkage away from the mould, and it could not be denied that there might be some part of the metal which solidified in close proximity to the mould wall, but there would always be a higher impedance through that metal than through the solid ingot cast which was sitting on the cold copper base.

Knowlson described the three chamber process, and that problem had been largely solved as far as the question of valves was concerned. There was left, however, an appreciable problem from the design point of view, namely, what to do when the valve was opened. The mechanics of passing a charge from the cold zone across a valve on to the hearth in the furnace, and subsequently out into the quenching zone, was a more serious problem than finding the requisite type of valve to do the job. For a relatively light charge, it was feasible to put in a pusher mechanism, and ram the charge through into the furnace zone when the valve had been raised into the open position. The ram was then withdrawn, the valve closed, and the charge was then ready in the chamber for heat treating. Similarly on the exit side, a grab mechanism connected on to the charge and withdrew it into the cooling zone. The problem was, however, more serious in the case of the heavy charge.

Finally, he asked Cook and Swainson whether they had any advice to impart on the problem of assembling electrodes inside the furnace prior to consumable melts. The section shown in their Paper of the Parke and Ham furnace, with cold compacting of powder fed from a hopper

into the assembly tube where it was rammed into contact, went back several years, and in recent years the N.S.C. had been experimenting with a slightly different approach to the problem. It was that of using tablets or pellets. The difficulty was that the welding technique had to be accomplished while the pellet was being guided to the requisite point.

Authors' Replies

E. Swainson, in reply to the point made by Kessel concerning the centralization of different parts of the induction coil in induction melting, referred him to the work done by Du Pont in melting titanium. A movable coil was used which was moved progressively down the crucible from the top of the charge towards the pouring nozzle at the bottom of the charge during the course of the melt, and it worked satisfactorily and gave reliable casting.

As to the question of casting under inert gas and whether it helped to make castings more sound, in the case of titanium one was trying generally to do that operation in vacuum. But it was sometimes necessary to work in inert gas, and the problem arose of trying to get rid of hydrogen. It was possible to reduce the hydrogen content significantly in inert gas melting, but it took a long time and necessitated sweeping with argon.

Knowlson touched on the relative advantages and disadvantages of Rootes pumps. On the whole, Swainson and his co-author would agree with the point made by Barrett and Harper in their Paper. Each type of pump had some advantages and disadvantages, and for their own particular purpose, he and his co-author preferred to use two types in parallel. One snag in connection with the pumps was that if they were left for a period of time after they had been used, there tended to be some danger of seizing when they were restarted.

He pointed out that vacuum locks were used in the furnace to which he had referred, and they were large diameter vacuum locks of up to 24 in. At the end of the first melting operation, the stub of the first metal electrode was plunged into the ingot and the ingot allowed to solidify round the stub of the first melted electrode. The whole of it was then withdrawn into the top of the furnace The vacuum lock valve was then brought underneath the suspended electrode, and it allowed the crucible to be changed and a larger diameter crucible to be put in for the purposes of a second melt. That took 15 to 20 sec. At the end of the second melt, another lock could be introduced. The time taken for the whole operation was reduced to something like 30 min.

It would seem that the measurements to which Moss referred would depend to some extent on the geometry of the furnace, and the conditions obtained with a relatively small diameter electrode were different from those obtained with a large diameter electrode. The authors were satisfied with the automatic control procedures which were used.

In reply to Child, the authors had run furnaces with connections to the bottom and to the flange, and with connections to both, and there did not appear to be any evidence that there was a great deal of difference between them. As a matter of convenience, it was probably easier to change crucibles more quickly if the connection were made at the flange. On the question of safety, there was not much point in making the furnaces a bit safer. Unless they could be made completely safe he would not be willing to take them out of a protective cubicle.

As to the point about giving advice on assembling electrodes inside the furnace prior to melting, his advice in respect of titanium and zirconium would be "don't." He did not know what the position was in respect of molybdenum. There might be some improvement in the method of making electrodes a separate stage, that is, continuous compacting. If one embarked on continuous assembling of electrodes inside the furnace, it did not make much sense unless the whole melting process were made continuous, and that introduced such complications that it was not worth while doing at present.

M. L. Noakes (A.E.R.E., Harwell), replying on behalf of J. Stephenson, who was unable to be present, said that the main aim was to heat the uranium as quickly as possible to avoid carbon contamination from the crucible. Carrying out a conventional melt of 150 kg., something like 600 p.p.m. were picked up, and heating time was approximately 40 min. The object in holding metal under inert gas was to avoid gas entrapment which affected the operation of fuel in the reactor at a later stage.

As to the query concerning a delay in opening the furnace in respect of uranium, it oxidized rapidly at 400° C. and there was a health hazard associated with it.

Dr. H. H. Scholefield, in reply, said that he used the half coil technique regularly because of the advantage of melting down. To invert it in order to avoid scaffolding was an idea, but he had not suffered a great deal from scaffolding. Again, argon was used in quite a number of cases for finishing the melt instead of casting under vacuum and suffering from possible residual gas or giving rise to porosity.

Efforts had been made to deal with the problem of the long cooling range. It was not felt that the Twinset technique was the entire answer, and it might be necessary to return to locks. He did not like locks, for in the earlier furnace there was a sizeable lock and it was always a source of trouble.

M. E. Harper, in reply, said that one of the advantages of the system of Rootes pumps and water ring pumps was that only one valve was required. Therefore, automation was unnecessary as only one switch needed to be put on. That could only be worked if one considered that Rootes pumps required something like 10:1 differential for operation. That obviously presented some difficulty, but rather than put in a heavy horse power motor, two methods were to use freely loaded Rootes pumps and, secondly, to use by-pass valves. One great advantage of the system was that if a pressure rise occurred the Rootes pumps no longer had to be valved up.

On the question of valves, his own view was that they required a great deal of maintenance and had to be used with extreme care.

A great deal of consideration was given to whether steam injectors should be included in the pumps covered by the Paper. It was felt, however, that as the steam injector was used in chemical engineering quite widely, most people would be well acquainted with it. The steam injector was competitive with the Rootes pump in capital cost and in performance. If, however, it was necessary to provide the steam supply, the costs were high.

The meeting then terminated.

Some of the members and guests at the annual banquet of the Institute of Metals :—Dr. and Mrs. E. G. West, Mr. and Mrs. C. Smith, Mr. and Mrs. J. C. Bailey, Dr. C. E. Homer, Dr. and Mrs. A. C. Street

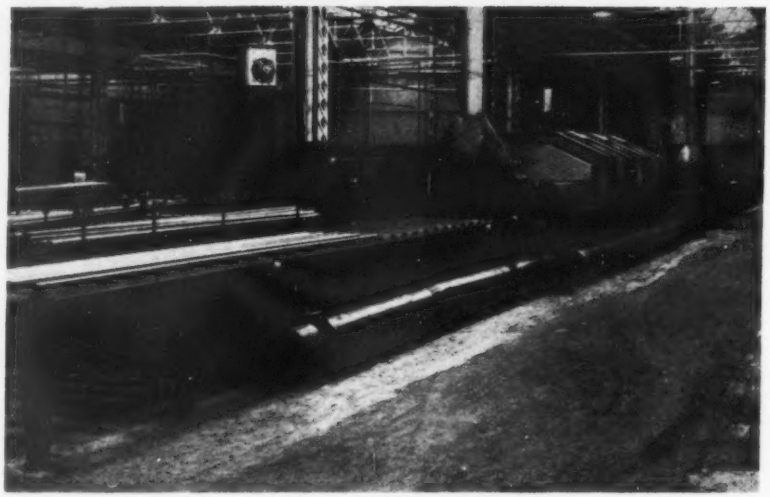
Bright Annealing Copper Tubes

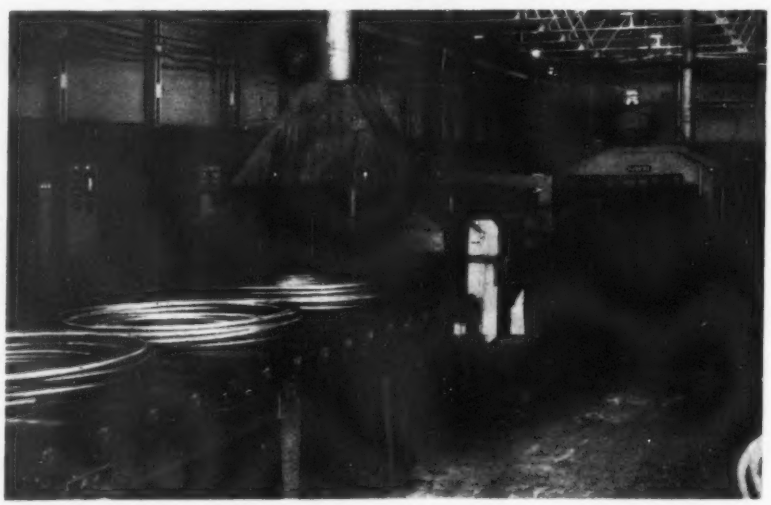
A RE-MODERNIZATION programme has recently been carried out at Earle, Bourne and Company Ltd., Birmingham, a member of the Delta Group, and included in the new installations is an electrically-heated driven roller hearth furnace supplied by G.W.B. Furnaces Ltd., of Dudley, Worcs., for the annealing of copper and brass tubes. Since the G.W.B. furnace operates under a protective atmosphere, the pickling process has been eliminated and the tubes now emerge from the discharge end quite bright in the case of copper tubes, and clean in the case of brass tubes.

The furnace is heated by electric resistance elements situated in the roof of the heating chamber, and in the hearth beneath the driven rollers. A maximum rating of 285 kW is provided, spread equally over the three-phase supply, and for control purposes, this rating is divided into three zones arranged longitudinally along the furnace. Each zone is fed through a transformer with a series of tappings to provide a reduced input when working on lighter loads beneath the maximum capacity of the unit.

The complete installation is nearly 150 ft. long, which includes a loading table 35 ft. long and an unloading table 40 ft. long. The most common charge consists of copper tubes in lengths up to a maximum of 35 ft. and with a diameter range from ½ in. to 4 in. outside diameter. This length is the maximum which can be catered for in straight form, and beyond this the tubes are coiled on a bull-block up to a maximum length of 60 ft., forming coils 5 ft. 6 in. diameter which are also passed through the furnace. The unit has basically been designed for an output of 2 tons/hr. of annealed tube, although this naturally varies with the particular charge characteristics. The average hourly throughput at the present time is 39 cwt. when in lengths and 35 cwt. when coiled. Working on these outputs, electricity consumption figures have been obtained over a five-day week, working 24 hr/day; 91 kWh/ton of tubes annealed in straight lengths which, on an average cost of electricity in the area where the works are situated, comes to 5s. 0½d. per ton of tubes, and 5s. 7½d. per ton of tubes in coil form.

The G.W.B. protective atmosphere plant consists of three combustion chambers in which a carefully determined mixture of town's gas and air is burned in a ratio of approximately 2½/3:1, the partially burned product being passed through a water-sprayed coke-filled "scrubber" box for cleaning and cooling, and then through purifying units containing bog-ore and activated carbon to reduce the sulphur content as far as possible. Gas consumption figures work out at 1,900 ft³/hr, which comes to nearly 950 ft³/ton, giving a cost of 5s. 2½d. per ton based on a local town's gas cost of 5s. 6d. per 1,000 ft³.





Loading end (above) and discharge end (below) of G.W.B. driven roller hearth furnace for annealing copper and brass tubes

All rollers are of mild steel except where they are situated in the actual furnace itself and in the first portion of the cooling chamber, in which case they are of drawn heat-resisting material. Arrangements are made for easy withdrawal of the tubes from the side of the furnace should this be necessary, without having to shut down the drive for the whole installation. A further point which materially assists in periodic maintenance is the division of the furnace roof into three sections equivalent to the heating zone lengths, which can be easily lifted off.

The 44 ft. long cooling chamber is water-jacketed, and effectively reduces the temperature of the charge coming from the furnace so that it can be handled on discharge, and it emerges into normal atmosphere well below the point at which oxidation might occur.

Each of the three heating zones are controlled independently and automatically by an Electroflo electronic indicating controller, while a 3-point recording instrument gives a permanent indication of thermal conditions along the length of the furnace. The speed at which the charge is borne through the installation is controlled by a Carter hydraulic infinitely variable speed gear, and to assist the furnace operator an indicator is mounted on the furnace, clearly showing the charge speed in ft/min.

Ingot Moulds

By J. C. WRIGHT, Ph.D.

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ONE-PIECE moulds, such as cannon moulds, are used to cast round or short rectangular billets, on which a slight taper can be tolerated. The taper is necessary to facilitate removal of the billet from the mould. The moulds either stand firmly on a bottom or they are suspended by trunnions from a casting wheel or frame, and are then closed by a plug at the bottom. Normally, the slight taper is such that the wide end is at the top when the mould stands on a bottom plate, and at the bottom when the mould is suspended. However, if handling is not difficult it matters little which way the taper lies. One serious disadvantage of the one-piece mould is the difficulty of access for cleaning and dressing. It is also more difficult to remove a jammed ingot from a cannon mould than from a two-part mould. However, the cannon mould is normally cheaper than the equivalent sized two-part mould, because it is cast in one piece and machined in one operation. Normally, the base of the mould is faced to provide good seating on the base plate. Many cannon moulds are bored through. A two-part mould is machined accurately along its meeting edges and requires a clamping device. Some thought has to be given to machining facility on the working faces when designing a mould, even when it will first enter service with as-cast faces. This attention should ensure that when refacing becomes necessary the machinist will have no difficulty with tool access.

Clamping devices for securing two-part moulds should be strong and simple. The simplest is a ring and wedge type of clamp. This is satisfactory for small moulds but requires too much manual adjustment and is clumsy on large moulds, particularly when they are hot. Large two-part moulds are best hinged and equipped with screw clamps or positive lever hook clamps.

The thickness of the mould wall is a major consideration in designing a solid mould for a given application. The function of the mould wall is to chill the ingot metal, absorb the heat released during ingot solidification, and radiate heat to the atmosphere as further ingot cooling takes place. At first sight it would seem that the higher the temperature diffusivity of the mould material, the more efficient it would be. While this is true, it must be remembered that the mould material is not the only material the heat has to penetrate on its way from the ingot. Heat from the ingot metal may have to cross a gap from the ingot to the mould dressing, dressing to mould scale, scale to ingot mould material, through the mould, and finally be transmitted to the atmosphere around the mould. The resistance of some of these barriers to the passage of heat can be of greater significance than the thermal resistivity of the mould material itself, so the nett effect on the rate of cooling of the ingot, made by using a slightly more conductive mould material, may not be very large. The rate at which heat can be removed is not only dependent on the temperature diffusivity of the mould and its associated dressing, scale, etc., it is also dependent on the temperature gradient across the whole cooling system. In a solid mould, the temperature of the inner surface quickly rises to a maximum during casting. On the other hand, the temperature of the outside of the mould is at a minimum only at the beginning of casting. This temperature will rise as the mould absorbs heat from the ingot and as it rises, the temperature gradient will fall and the rate of cooling of the ingot will also fall.

The reason for the temperature rise at the outer surface is that a further resistance to heat transmission is created when heat has to be lost to the atmosphere surrounding the mould. Until the temperature of the outside of the mould begins to rise, the thermal capacity of the mould largely determines the rate of cooling of the ingot. The accepted design principle is that the ingot mould should be capable of absorbing the superheat and latent heat of solidification of the ingot before the outside surface temperature of the mould rises significantly. In this way, the ingot should be solid before the cooling rate decreases. This critical mould thickness can be calculated with a fair degree of accuracy, knowing the heat released from the ingot, the average temperature of the mould before its outer surface temperature rises, and its specific heat. Using this method, it is found generally that moulds for small ingots tend to be too weak mechanically, and for very large ingots the theoretically designed mould would be extremely heavy. If no other considerations enter into the design, a compromise is reached, whereby small moulds are made heavier than thermal considerations suggest and large moulds are lightened in section. There is a limit to how much can be removed safely from a solid mould, and this is a very good argument in favour of using water-cooled copper moulds for very heavy ingots.

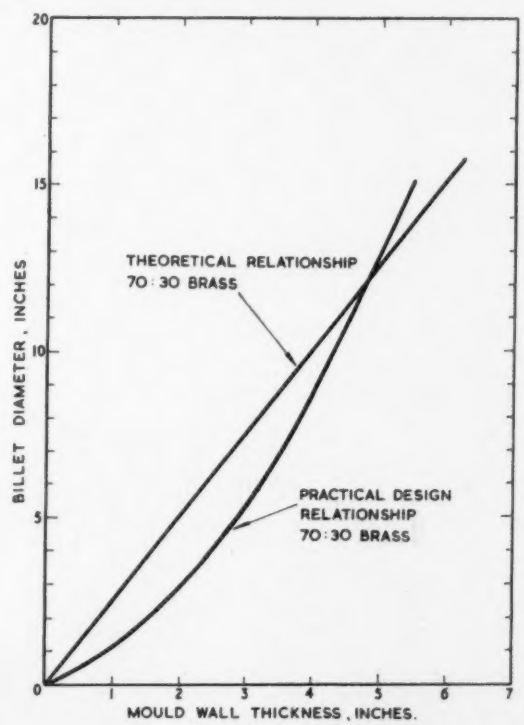


Fig. 5—Typical relationship between ingot size and mould wall thickness for cast iron moulds

The relationship between mould wall thickness and ingot size is shown in Fig. 5 for 70:30 brass ingots poured at 1,180°C. into a cast iron mould preheated to 80°C., assuming the maximum temperature reached by the working surface of the mould was 700°C. In effect, the mould chill has to be almost exactly twice as heavy as the ingot to meet the design principle. On a volume basis, there should be 2-3 times as much mould chill as brass. Also plotted in Fig. 5 is the way in which the theoretical requirements would be modified in practice when designing ingot moulds for brass cast under the above conditions.

Another consideration which might be taken into account is the required macrostructure of the ingot. Thus, to extend columnar growth in a particular direction, the mould section normal to the growth direction is increased, and vice versa. It is evident that each ingot mould should be designed for a specific alloy or group of alloys, for particular ingot sizes, and for a predetermined ingot structure. Close co-operation between the casting shop executive and the ingot mould designer and manufacturer is necessary to achieve the best results.

Water-Cooled Moulds

With large ingots, the mass of a solid ingot mould with adequate heat capacity becomes so large that the mould is very cumbersome. If the mass of the ingot mould is not to be increased, then the rate of heat transfer through the mould wall becomes important. The rate of heat transfer can be increased by increasing the temperature diffusivity of the mould material and by increasing the temperature gradient across the mould wall. The resistance of the mould wall in a given material to the passage of heat is directly proportional to its thickness and inversely proportional to its thermal conductivity. Obviously, the mould wall should be made from high conductivity material, be as thin as possible, and the temperature gradient maintained across it as steep as possible. The limiting factor to thinning down the mould wall is one of mechanical strength. In practice, the above conditions are provided by a water-cooled copper mould. Such moulds are frequently referred to as Junkers moulds after one of the originators, who was mainly responsible for introducing water-cooled copper moulds into industry[3] in 1922.

The material used for the working surfaces of water-cooled moulds is normally high conductivity copper or deoxidized non-arsenical copper. It is advisable to strengthen the copper to some extent as long as the thermal conductivity is not too severely reduced, because unalloyed copper is very vulnerable to mechanical damage. An addition of about 1 per cent of either chromium, silver or cadmium is effective. Table I shows typical thermal conductivities and corresponding hardnesses for various types of copper.[4]

TABLE I—CHARACTERISTICS OF COPPER MOULDS

Type	Thermal Conductivity (c.g.s. units, 20°C.)	Hardness (D.P.N.)
O.F.H.C. copper	0·948	51
Deox. non-As. copper	0·725-0·850	53
H.C. copper	0·948	53
Copper + ½ per cent Cr, heat-treated	0·73	142

Even after hardening the copper by alloying, and possibly retaining some cold working hardness, the copper will still be very much softer than cast iron, and it is necessary to design the water-cooled mould in such a way as to prevent the copper lining being damaged. The copper is usually ¼ in. to ⅜ in. thick, in the form of rolled plate, solid drawn tube or a shell machined from the solid. A tube or machined shell avoids joints at the long corners of the mould or seams in a circular billet mould, thus discouraging metal penetration. Usually, the outer casing of the mould is of cast iron or cast steel, and the copper lining has to be sealed into this. The joints between the lining and the outer casing can be made with lead gaskets, lead wire, or with thin woven asbestos strip coated with white lead.[5] The joints should be so positioned that water cannot leak through them into the mould unless the lining itself fractures. The whole of the water-cooling system should be designed to withstand full water mains pressure without leaking. It is not likely that the pressure in the mould case will rise to the full mains pressure, but in the event of a blockage in the outlet, the full pressure might be thrown on the system. Blockages are best prevented by placing filters in the inlet port of the mould water jacket, and by periodic inspection of the whole mould structure after removing the copper facing. A large flow of water is required through the mould, but it is important that the water should flow effectively over the whole cooling face at an appreciable velocity, in effect scouring the heat away.

To prevent a static layer of water adjacent to the cooling face, baffles are mounted in such a way that water entering at the bottom is driven upwards in a spiral fashion and out at the top. A large flow of water is required through the mould. It has been found that cooling conditions suitable for casting brass rolling slabs weighing 1,000 lb., in Junkers-type moulds, can be obtained by circulating water at approximately 100 gal/min., and maintaining its temperature at approximately 71°F. (21°C.). Under normal conditions, this water temperature is sufficiently high to prevent condensation on the mould working surface prior to casting.[5] It is important that the water should, at no point in its cooling process, reach boiling point, even temporarily. Evolution of steam within the cooling jacket would immediately reduce the efficiency of the cooling process and possibly lead to warping of the cooling face through local overheating.

Water-cooled moulds rarely fail by cracking or deterioration of the working surface. They are more likely to give trouble due to the copper face plate bulging and possibly causing leakage at joints. The bulging is caused by differential expansion of the inner and outer faces during casting. In the early stages, the bulging may recover to a large extent when the mould is not in use, but gradually a permanent bulge is created and, if not corrected, cracking is likely at joints and screw holes, leading to leakage. The flatness of the cooling surface should be checked regularly on every mould and when the distortion exceeds a maximum, usually about $\frac{1}{16}$ in. out of true, the copper lining should be removed and either corrected or replaced. It is possible to replace the copper lining many times before a well designed outer shell is damaged beyond repair.

Mechanical Devices

Various aspects of ingot mould practice can be mechanized. Moulds may be fixed on carriages and brought in turn under the pouring position. Hinges on moulds have been mentioned previously. When one-half of a hinged mould is secured to, say, the casting pit wall, all or most of the weight of the mould is taken by the fixtures even when the mould is open. Devices for extracting ingots from the moulds become attractive, particularly for heavy ingots. These may vary from simple trolley cradles manoeuvred by hand to automatic hydraulic ram extraction units (Figs. 6 and 7). Suspension of moulds on carriages may be applied to both solid and water-cooled moulds. The moulds may move in a straight line in a carriage on rails, in the form of an endless chain (as in a pigcasting machine), or on the periphery of a wheel. With water-cooled moulds, it is necessary to arrange a water supply to a central point on the appliance for feeding the individual moulds. Taking a casting wheel as an example; each mould is connected to an upper and lower main, which encircle the wheel and which are connected in turn to service mains by means of a rotary swivel joint at the hub of the wheel. One installation of

this type[6] includes a closed circuit of the ring of moulds, a heat exchanger, surge tank, and centrifugal pumps. The heat exchanger in this case consists of a number of large copper blocks, each drilled with a multiplicity of internal passages and connected in parallel. Cooling water and mould circulating water flow through alternate channels in entirely separate circuits. The amount of heat removed by this system varies according to pouring rate and ingot shape, but it approximates 500,000 B.Th.U/ton of copper cast. The mould temperature is controlled by a thermostat controlling, in turn, the external cooling water flow to the heat exchanger.

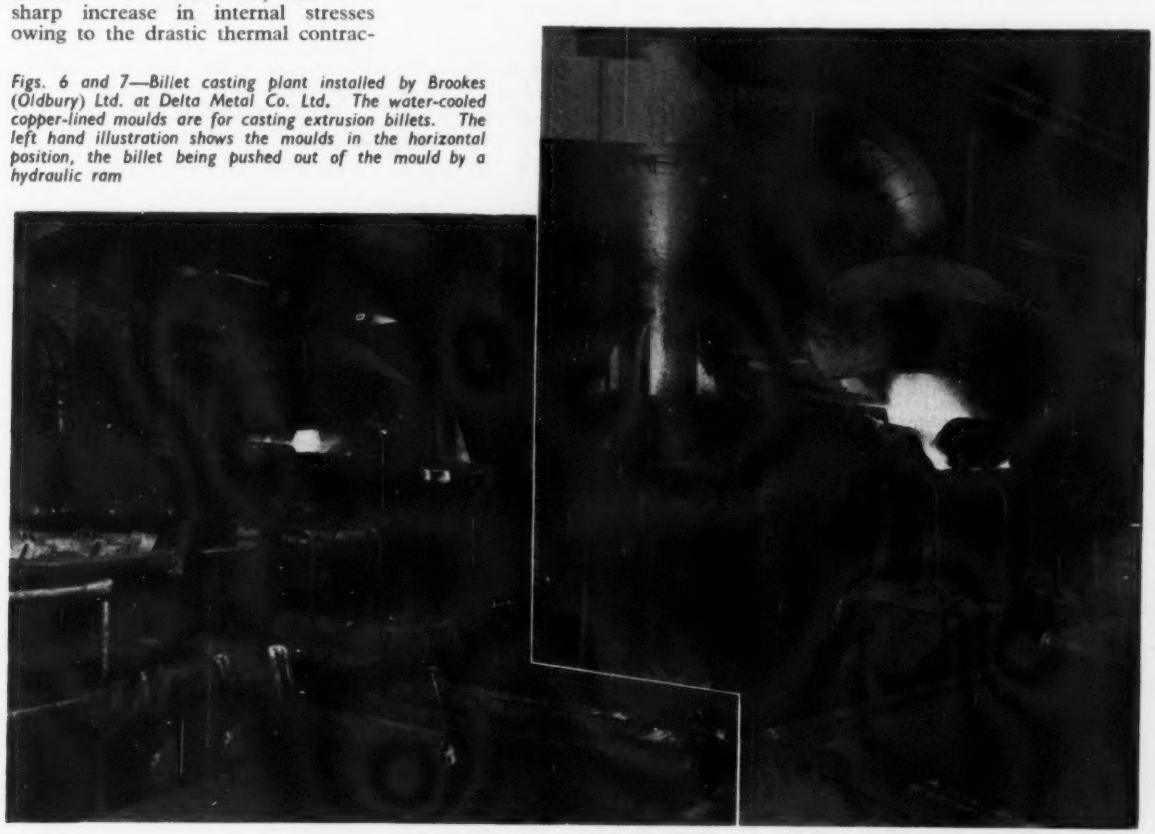
Casting Pit Practice

Frequently, casting pit practice can be modified to increase the average life of the ingot moulds. For instance, the temperature at which an ingot is taken from a mould is important. Leaving a high melting point ingot in a mould until it is completely cold is unnecessary and increases mould oxidation. On the other hand, removal of an ingot when it has just solidified is also unwise, because the mould will be very hot internally, and consequently prone to damage. It is also likely that the thermal contraction of the ingot will not have proceeded sufficiently to allow easy removal from the mould. Quenching a hot ingot mould is very deleterious to mould life, due to a sharp increase in internal stresses owing to the drastic thermal contraction and thermal gradients. If at least two sets of moulds can be used during casting, so that a mould is not used immediately the previous ingot has been withdrawn, there is no need to quench moulds in between casts. Correct choice and use of ingot mould dressings can do much to increase the average mould life. In cast iron moulds, particularly, careful application of mould dressings can prevent crazing developing at a fast rate. Mould dressings are also of great assistance in helping to minimize erosion of the mould surface by molten metal. This is not sufficient in itself. In all moulds, pouring should be done so that impingement of the molten metal on the mould is not localized in such a way as to cause erosion. The stream should either be divided or the pouring device rocked slightly so that the main stream is spread over the pouring surface. Some moulds are designed with replaceable splash plates, which take the bulk of the impact of the stream.

Ingot Mould Practice

In batch casting of slabs of zinc and zinc alloys, cast iron moulds are employed either pouring horizontally or vertically. Inert refractory dressings are used, and mould life is normally very good because the conditions are not very arduous. Usually, the cast iron moulds are mounted on a wheel and, in the case of horizontal moulds, they are water-cooled by either directing water sprays against the underside or extending cooling fins down into a cold water trough. By these means, the mould temperature can be held at 100°-160° C., which is satisfactory.[7] Horizontally cast slabs are liable to sink on the top surface unless feeding is encouraged by various types of "hot-tops." The Erichsen mould also helps to minimize sinking. This mould is designed in such a way that the side-walls may be heated if necessary, but in all cases the bottom is water-cooled. Thus, directional solidification is promoted from the bottom upwards. The casting base plate is made in either copper or cast iron. Because of the severe chilling action of a water-cooled copper base, cold shuts tend to occur and water-cooled cast iron is often preferred. The horizontal moulds are cheap and simple, but slab casting in vertical moulds offers a better degree of casting control. When slabs of the highest quality are required for strip production, Durville type casting methods are used.

For extrusion billets of zinc alloys, the mould is generally a solid wall cast iron one with a detachable bottom plug and a slight bore taper to facilitate ingot ejection. The upper half of the mould may be lagged to ensure slower cooling of the metal in this region. The ingots are poured through a tundish into a vertical mould at a



Figs. 6 and 7—Billet casting plant installed by Brookes (Oldbury) Ltd. at Delta Metal Co. Ltd. The water-cooled copper-lined moulds are for casting extrusion billets. The left hand illustration shows the moulds in the horizontal position, the billet being pushed out of the mould by a hydraulic ram

temperature of about 80°C. and top fed, using a hand ladle.

Light Alloys. Most light alloy ingots for subsequent working are produced by the semi-continuous casting process. The size of ingots and rate of production required almost precludes the economical use of batch casting methods. Cast iron moulds may be used for batch casts, and their service life is very long, but most batch casts are made in water-cooled moulds. Even with water-cooling it is difficult to attain a fine uniform grain structure if the ingot diameter or major diagonal exceeds about 12 in. Above this size, the direct chill semi-continuous process is the obvious choice for aluminium, magnesium and their alloys.

Batch casting almost invariably utilizes a Durville method for both aluminium and magnesium alloys. A mould, for magnesium alloys, having a slot gate running into the mould cavity down the whole of its length and with a varying solid wall section, giving a heavier chill at the base, has recently been described.[8] Such moulds quickly develop a favourable temperature gradient from top to bottom, the magnitude of which varies with diameter but typically is of the order of 100°C. Sketches of this mould are included in Fig. 8.

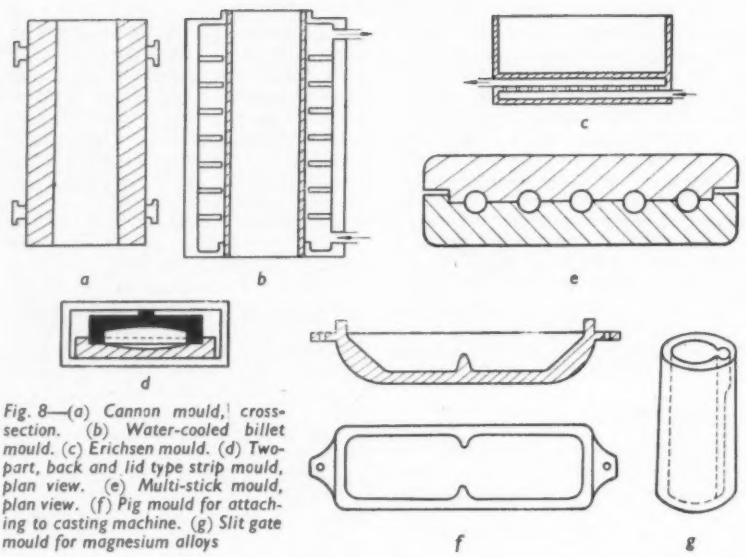


Fig. 8—(a) Cannon mould,[1] cross-section. (b) Water-cooled billet mould. (c) Erichsen mould. (d) Two-part, back and lid type strip mould, plan view. (e) Multi-stick mould, plan view. (f) Pig mould for attaching to casting machine. (g) Slit gate mould for magnesium alloys

Copper and Its Alloys. Direct chill methods of casting this group of alloys have not yet developed to the stage where they have taken over a significant proportion of the ingot tonnage. Batch casting methods are still standard practice. Where solid moulds are used, cast iron is the normal material for them. The casting of copper alloys and alloys of even higher melting points, in cast iron moulds produces a set of arduous conditions for the moulds. Cast iron moulds in this category must be produced with an eye to the best type of iron for the mould, the best design, and good foundry practice, in order to obtain a reasonable mould life. Stress cracking on a major scale can be eliminated as a cause of failure, but crazing and erosion of the mould will limit the life of the mould when casting these alloys much more quickly than for the lower melting point alloys. Many of the difficulties are overcome by using water-cooled moulds. Their popularity has been rather more consistent with copper alloys than with nickel alloys. Cast iron moulds are still used in production of the multifarious shapes and sizes of castings encountered in the wrought brass industry, although water-cooled copper face moulds are preferred for producing ingots of standard sizes where the quantities of ingots required are high.

When water cooling is applied to copper-faced moulds, it varies from water spraying of the underside of a solid copper mould, through a massive copper mould with channels drilled in it to take the cooling water, to the water-cooled thin copper wall of the Junkers type mould. The bottom sprayed solid copper mould is common practice in producing copper wirebars. The drilled channel copper mould has been used for the production of rolling slabs, cakes and extrusion billets in copper and various copper alloys.[6,9] It has an advantage over the thin-wall Junkers mould in that a certain amount of distortion can be machined out without risking a puncture of the wall through to a cooling channel.

Nickel and Its Alloys. Casting pit practice with nickel and its alloys in many respects resembles steelworks' practice rather than non-ferrous ingot methods. There is no evidence of widespread use of water-cooled moulds in the nickel industry, and a large tonnage is cast in cast iron solid moulds. At least three methods of ingot casting are employed: uphill casting of a cluster of moulds, bottom fed via casting trumpets and base runners; Durville type casting, and conventional top casting.[10]

Acknowledgment

The author acknowledges with thanks the co-operation of the executive staff of the Barrow Hæmatite Steel Co. Ltd., ingot mould producers, Barrow-in-Furness, to whom he acts as metallurgical consultant.

References

[3] E. J. Bradbury and P. G. Turner; *J. Inst. Met.*, 1948-49, **75**, 373.
[4] Smithells; Metals Reference Book, Butterworths Scientific Publications, London, 1949.
[5] M. Cook & C. L. M. Cowley; *J. Inst. Met.*, 1953, **81**, (7), 341.
[6] R. H. Waddington, *J. Inst. Met.*, 1948-49, **75**, 311.
[7] L. W. Roberts & B. Walters; *J. Inst. Met.*, 1953, **81**, (7), 365.
[8] R. G. Wilkinson & S. B. Hirst; *J. Inst. Met.*, 1953, **81**, (7), 393.
[9] J. Sykes; *J. Inst. Met.*, 1953, **81**, (7), 351.
[10] J. Thexton; *Met. Ind.*, 1958, **93**, (14), 279.

Radiography

A COBALT container with a source of 1,500 curies has been developed for industrial use by Newton Victor Ltd., the X-ray department of Metropolitan-Vickers Electrical Co. Ltd., Manchester, 17.

The Newton Victor industrial cobalt container is particularly suitable for work on large construction sites, especially in remote areas, as, in addition to its inherent reliability, it is largely independent of electrical and water supplies. Small currents are necessary for control purposes, but the quality of the radiograph is not dependent on the maintenance of precise voltages and frequencies. No water or oil cooling is necessary, and ambient temperatures up to 150°F. will not influence the operation of the container.

A worm wheel drive is used to angulate the container, and thereby the beam of radiation, through 350°. The cobalt source is housed in a lead and heavy alloy protective container thick enough to reduce the intensity of the radiation at the surface to 6·25 milliroentgens/hr. with a source of 1,500 curies. The source is housed at the periphery of a disc which moves through 180° from the "protected" to the "exposed" position. Adequate clearances are possible without any loss of protection, as the source wheel is, in all positions, totally surrounded by the lead and heavy metal protective shield.

Finishing Supplement

Surface Treatment of Aluminium

By F. FLUSIN

(*Concluded from* METAL INDUSTRY, 17 *April*, 1959)

DEPENDING on the nature of the metal, the appearance of the anodic film will vary.

Super purity (99·99 per cent) aluminium. Super purity aluminium can only give rise to the formation of pure and perfectly transparent aluminium oxide. This means that, after an anodic treatment, super purity aluminium will have exactly the same appearance as it had before the treatment. In particular, if super purity aluminium has been brightened prior to oxidation by chemical or electrochemical brightening, anodizing will in no way reduce the effect produced by the brightening treatment. The metal will remain just as bright after a film 15-20 micron thick has been applied. This behaviour enables the use of super purity aluminium, brightened and anodized, for costume jewellery (an application which, in France, consumes 15 tons of the metal per month), and, above all, for public lighting reflectors, an application which is now almost exclusive to light metal. The metal used for the reflectors acquires a very high reflectivity (of the order of 85-90 per cent for white light) by the brightening treatment, which reflectivity, as has just been pointed out, is not affected by the subsequent anodizing.

Commercial purity (99·5 per cent) aluminium. Commercial purity aluminium contains 0·5 per cent of impurities, chiefly iron and silicon.

Consider the cross-section through a sheet of commercial purity aluminium, a very much enlarged grain boundary, as shown in Fig. 6. The iron and silicon have collected in this grain boundary. When, during anodic oxidation, oxygen arrives at the surface of the metal, it will oxidize the aluminium, but it will also arrive at the grain boundary. It will oxidize the iron, which will dissolve in the electrolyte. The silicon will remain in the oxide film in the form of silicon black in the position originally occupied by the grain boundary. At the same time, the disappearance of the grain boundary will cause a slight heating, which will have the effect of enlarging the space occupied by the former grain boundary. These three factors: disappearance of the iron, slight increase of the former grain boundary, and the residual silicon black left in the oxide film, will have the effect of emphasizing the location of the former grain boundary; an optical effect will occur equivalent to that observed when a motor car windscreen made of safety glass develops a multitude of fine cracks: the oxide film will become opaque.

Commercial purity aluminium which has been brightened by chemical or electrochemical treatment will be tarnished by anodizing, and will assume the milky, opalescent appearance characteristic of anodized aluminium. Naturally, the exact appearance of this opalescent finish will depend on the thickness of the oxide film.

Aluminium-copper-magnesium alloys of the Duralumin type. The copper (about 4 per cent) is concentrated at the grain boundaries. It dissolves during anodic oxidation by a mechanism equivalent to that of the preceding case, with the result that the anodic film will contain large grooves in the positions corresponding to the location of the copper.

This means that in the case of Duralumin-type alloys the oxide film will have the same appearance as on commercial purity aluminium, but, in addition, the film will be extremely porous. Its protective value will be correspondingy less, but, on the other hand, the film will be more easy to dye.

Aluminium-magnesium alloys. In aluminium-magnesium alloys, the magnesium, which is present in the grain boundaries, is oxidized to a compound rich in magnesium oxide related to the spinels. This compound remains in the oxide film, colouring it grey, the intensity of the grey coloration depending on the amount of magnesium not in solid solution.

In the case of certain aluminium-5 per cent magnesium alloys, when it happens that a considerabe proportion of the magnesium is not in solid solution, the metal after anodizing is practically black. In that case, the anodic film is removed by pickling, and the parts are given a heat-treatment intended to put the magnesium into solid solution, say 3 hr. at 520°C. Work treated in this way will be found to develop a light coloured finish on anodizing.

Aluminium-silicon alloys. The silicon, which may be present in the alloy in amounts from 5-6 to 13 per cent, remains in the oxide film as silicon. The colour of the film will be grey, the depth of the grey increasing the higher the silicon content and also the smaller the grain size of the silicon in the alloy. This colour developed by aluminium-silicon alloys on anodizing is used in architecture for decorative purposes. Thus, the building of the Prévoyance Sociale in Brussels incorporates spandrels of anodized aluminium - silicon alloy containing 5 per cent silicon.

Colouring

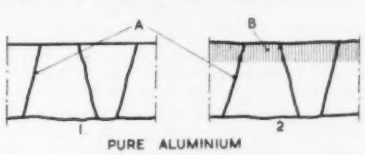
The oxide film being porous, this porosity can be put to good use to allow colouring matters, generally organic dyestuffs, to penetrate into the film.

Hot solutions of dyestuffs are used, containing from a few gm/L of dye for deep colours (10 gm/L for black) to a few tenths of a gramme for light colours.

There are also inorganic colouring matters which are used extensively for architectural applications of aluminium. Brass-coloured finishes, for example, are obtained by making use of solutions of ferric ammonium oxalate, from which iron hydroxide is precipitated in the film. Bronze colorations are obtained with the aid of potassium

Fig. 6—Appearance and porosity of anodic films on different alloys

A—Grain boundary. B—Anodic film. C—Grain boundary containing Al_2Cu. D—Grain boundaries where the copper has been dissolved. E—Grain boundary containing Al_3Mg_2. F—Grain boundaries filled with a compound rich in magnesium oxide



1 and 2—Before and after anodizing; the film is continuous and transparent

3 and 4—In the course of anodizing the copper is dissolved out of the grain boundaries. The porosity of the film is greater than in 2

5 and 6—In the course of anodizing the magnesium is oxidized to a compound rich in magnesium oxide which gives the film a grey colour. The porosity is less than in 2, and for obvious reasons, than in 4

permanganate, together with cobalt acetate as a reducing agent.

One fault in dyed anodized work that is worth considering is the occasionally observed variation of the depth of colour over a large plane surface. The fault consists in the depth of colour being much greater near the edges than at the centre of the sheet. It is solely due to a lack of adequate stirring of the bath during the anodizing of the work.

As has been explained above, anodizing is accompanied by the evolution of heat. In the case of a large sheet, the heat evolved near the centre of the sheet flows in all directions within the sheet. On the other hand, the heat generated near the edges only has half the area into which it can spread, in view of the barrier to heat flow between the edge of the sheet and the electrolyte. The result will be that the temperature of the sheet will be a little higher near the edges than at the centre. Consequently, the dissolution of the oxide film will be more marked, the pores in the film more open, and the current density greater near the edges of the sheet. A more porous and thicker film will, therefore, be formed near the edges. When the sheet is dyed, the film over these portions of the sheet will consequently acquire a deeper colour than the film over the central portion of the sheet, for the same time of immersion in the dye bath.

To avoid this fault, it is necessary to ensure a uniform temperature over the whole sheet by vigorous stirring of the anodizing bath.

Light Fastness

The international light fastness scale comprises a range of grades from 1 to 8 relating to specimens of dyed wool. These grades correspond to increasing periods of exposure in the Fadeometer under prescribed test conditions. A fastness of 1 corresponds, let us assume, to a 2 hr. exposure of specimen 1 which will produce a 20 per cent fading of the colour. A fastness of 8 corresponds to an exposure of 250 hr. which produces a fading of specimen 8 by 20 per cent.

Dyes used for anodized aluminium, which is to be exposed out of doors, must certainly have fastness values above 8. The Americans have also established a light fastness scale, but a fastness of 8 on the American scale corresponds to an exposure of 5,000 hr. This light fastness, equivalent to a 5,000 hr. exposure, is attained by the following: the yellow brass colour obtained using the ferric ammonium oxalate bath; the bronze colorations obtained using potassium permanganate; a black colour obtained using a dye supplied by Durant and Huguenin, of Basle; and the yellowish green colour obtained by sealing the anodic film in a potassium or sodium bichromate solution.

It is not impossible that other organic dyestuffs will also prove satisfactory. Tests in this connection are still in progress.

Sealing

The principle of the sealing treatment using boiling water is based on the fact that the aluminium oxide formed by anodic oxidation is anhydrous. When this film is brought into contact with boiling water, each molecule of anhydrous aluminium oxide combines with a molecule of water to form an aluminium oxide monohydrate, the specific volume of which is greater than that of the anhydrous aluminium oxide from which it has been formed. The result will, therefore, be that each volume of aluminium oxide will expand, come into contact with adjoining volumes, and produce a continuous film of oxide free from pores.

In order that this may be achieved in practice, the sealing treatment must conform to the following essential conditions:

(1) The water used must be demineralized water, rain water, or distilled water.

(2) The temperature must be between 95°C. and 100°C., preferably 100°C., that is to say, at the boiling point.

(3) The *p*H must lie between 5·5 and 6·5. This is obtained either by the addition of acid (acetic, sulphuric) or of alkali (soda or sodium acetate), depending on changes in the *p*H value.

(4) The time of the sealing treatment should be equal to that of the anodic treatment.

Laboratory tests have shown that the sealing effect obtained after treatments lasting 1 hr., 2 hr. and 3 hr. was very much superior to that obtained after a treatment of ½ hr. The longer the sealing treatment, the better the result.

It has just been said that the best way of controlling the temperature of the sealing bath is to keep it at the boiling point. However, this does result in considerable losses of both water and heat, so much so that an exhaust hood will have to be fitted to avoid "steaming out" the shop: the loss of water per sq. metre of surface is 400 kg. every 10 hr.

A valuable saving—of the order of 40-50 per cent—can be made by fitting the sealing vat with a thermostatic control and setting it just below the boiling point (97°-98°C.). This will ensure that the sealing is still excellent, while at the same time there will be a saving in both water and heat, and, therefore, in cost.

Evaporation can also be limited by covering the surface of the bath with plastics bubbles of 30-40 mm. diameter, which will reduce the surface from which evaporation can occur and, consequently, the loss of water.

Sealing in potassium bichromate is very useful. It uses a boiling aqueous solution containing 1 to 5 per cent of potassium bichromate. The effectiveness of this sealing treatment has been confirmed by some tests in which specimens of untreated, anodized, and of anodized Duralumin sealed in a 0·7 solution of potassium bichromate were exposed to artificial salt spray. The untreated and the anodized specimens showed marked signs of corrosion after six months and two years, respectively. The specimens which had been anodized and then sealed in the potassium bichromate solution showed no traces of corrosion after eight years.

Sealing in potassium bichromate solution thus ensures extremely effective protection against corrosion in marine conditions. It should be used whenever the yellowish green coloration which it produces is not otherwise objectionable.

For this sealing process to be effective, it is essential that it should be carried out at the boiling point, and that it should be continued for at least half an hour.

Tests

The anodizing bath must be analysed from time to time. The content of aluminium in the bath must not exceed 12 gm/L. Even with 10 gm/L, the bath will contain impurities and contaminants which alone will justify the scrapping of the bath. The cost of sulphuric acid is sufficiently low to make it worth while to replace the bath rather than to try and regenerate it.

The *p*H of the sealing baths must be checked three times a day. That of the dye baths should be checked daily. A *p*H meter is just as important in an anodizing shop, if not more so, than an instrument for measuring the breakdown voltage of the oxide film.

As regards the anodized work, the first test is for the thickness of the oxide film. The test based on the measurement of the breakdown voltage is certainly the simplest. It determines the thickness with sufficient accuracy, provided it has been calibrated using specimens having oxide films of known thicknesses.

A very important test is the one concerned with the effectiveness of the sealing treatment. It is carried out by placing a few drops of a solution of anthraquinone violet dye on the surface of the anodized work. If the film has been properly sealed, the dye does not take. If, on the other hand, the sealing is inadequate, the dye will penetrate into the film and leave an indelible mark. This test is just as important as the breakdown voltage test.

In conclusion, it may be remarked that an anodizing shop should be run on the same lines as an engineering workshop, i.e. the operatives should make use of instruction sheets, which should be carefully observed. Only in this way will it be possible to ensure the output of work of the highest possible quality.

Industrial News *Home and Overseas*

Copper Development

On the evening of Thursday of last week (April 23), a number of prominent members of the engineering industry accepted the invitation of the **Copper Development Association** to attend a reception in the showrooms of the association in London. The guests were able to meet members of the Council, management committee, and technical staff, with whom they were able to discuss some of the many facets of engineering covered by the services of the C.D.A. in all matters appertaining to the use of copper and its alloys.

The occasion had been arranged to coincide with the Engineering, Marine, Welding and Nuclear Energy Exhibition at Olympia, with which many of the guests were concerned and in which the C.D.A. had also been participating.

Aluminium in New Zealand

Between 15 and 20 per cent of the £2 million capital required for the proposed aluminium factory in New Zealand will come from New Zealand interests, the chairman of Aluminium Ltd., Mr. P. J. Elton, said in Wellington recently, before leaving for Canada and the U.K. Mr. Elton was in New Zealand to negotiate the establishment of the industry by the Northern Aluminium Company of the U.K. No site had yet been chosen for the factory, he said. Deputations from several towns had asked the company to consider their areas.

It would take a number of years for the factory's operations to become comparable in size with those in other countries of similar living standards, Mr. Elton said. But the company would make every effort to build up a "worthwhile" industry as soon as possible. Production would begin in stages during the next 18 to 20 months, he said. The company believed that many New Zealand industries would benefit from a ready supply of aluminium products at reasonable prices, and this would encourage new uses and new ancillary industries.

Mr. Elton added that the establishment of the new factory had been helped by the encouragement received in New Zealand, particularly from the Government.

Heaters and Furnaces

Among the many interesting exhibits provided at the Engineering, Marine, Welding and Nuclear Energy Exhibition, which ended yesterday (Thursday), was that of **Electrothermal Engineering Ltd.**, who drew special attention to their armoured heaters and flexible furnaces.

The "Flexible" furnace has been developed for applications requiring operating temperatures and wattage densities exceeding those obtainable with other types of Electrothermal flexible heaters. Such heaters can be provided having almost any practical dimensions where there is a requirement for rapid heating, easily controlled rate of heating, and working temperature up to 1,000°C. The "Flexible" furnace is stated to be capable of producing concentrations of heat in a variety of applications, and is well suited to the arduous duties required of heaters in heat-treatment processes, nuclear power plants, chemical and industrial plant processes, and high temperature testing of structures.

The armoured heaters have already found wide acceptance in the heat-treatment field, and are primarily designed for the pre-heating and stress relieving of welds. Within their temperature range, these heaters will readily heat-treat to code requirements, the number of heaters used depending upon the application and power source available.

The heaters are produced in standard lengths for safe use on 50 V, 75 V and 100 V, and may be used with any of the following supplies:—welding generator, welding transformer, and mains supply transformer.

Instrument Technology

On Wednesday next, May 6, the annual general meeting of the **Society of Instrument Technology** will be held at 5.30 p.m. at Manson House, 26 Portland Place, London, W.1. This will be followed by the presentation of the "Bowen Prize" by Mr. R. Barrington Brock, M.B.E., President of the Scientific Instrument Manufacturers' Association of Great Britain, to Mr. J. E. Samson, for his Paper on "Dynamic Characteristics of Pneumatic Transmission."

After this presentation, the President of the Society, Mr. J. F. Coales, O.B.E., M.A., M.I.E.E., F.Inst.P., will deliver his presidential address, which is entitled "The Education of Instrument Technologists and Control Engineers."

Power Press Safety

An interesting report (the fourth) has been published by the Joint Standing Committee on Safety, of the Ministry of Labour and National Service, and deals primarily with the report of a special subcommittee set up in 1955 to consider methods of control of friction in clutch-operated presses.

The sub-committee has made a number of detailed recommendations (set out in Appendices 1-4) covering air and electrical equipment and clutch and brake design, which give an important line of guidance to machine designers. They had particularly in mind those faults in electro-pneumatic control systems which cause the machine to make a repeat stroke, not intended by the operator, possibly when the interlock guard is in the open position, and they recommend that all presses which are driven by electrically or electro-pneumatically controlled friction clutches, should be fitted with a special safety device.

Appendices 5-8 to the sub-committee's report contain detailed technical descriptions, illustrated by photographs and diagrams, of mechanically and electrically operated over-riding anti-repeat devices, a brake fault detection system, and a method of safety control of pilot operated control valves. Details of another device have been added by the standing committee, and appear as Annexe 2 to their report.

This report may be obtained from H.M. Stationery Office, price 2s. 6d. net.

Turkish Copper Refinery

Test runs have been completed and work on Turkey's first electrolytic copper refinery at Kagathane, near Istambul, has progressed so far that it is anticipated that full-scale production may start at the beginning of next month. Once the plant is operating, Turkey will no longer have to export her blister copper to West Germany for refining.

Rhodesian Copper

Northern Rhodesia last year became the second biggest producer of copper in the free world. The Chamber of Mines Year Book for 1958 gives figures for the first nine months of the year which show that the Copperbelt has beaten Chile into second position in the list of the western world's major producers. The United States retained its predominant lead with an output of 759,023 tons during the period to which the figures refer—the first three-quarters of the year. Northern Rhodesia was next with 354,204 tons for the same period, and Chile was third with 338,883 tons.

Transistor Exhibition

At the International Transistor Exhibition, to be held at Earls Court, London, this month (May 21 to 27), **Johnson, Matthey and Company Ltd.** will depict on their stand (number 47) many of their activities. Among the items to be exhibited will be the following:—

A number of high-purity metals for semiconductor devices including aluminium, antimony, arsenic, bismuth, cadmium, gallium, gold, indium, lead, mercury, platinum, selenium, silver, tellurium, tin and zinc. In most cases these metals are available in two or more different standards of purity.

A wide range of base and noble metal solder and contact alloys for semiconductor devices; salts and anodes for the electrodeposition of gold, silver, platinum, rhodium and indium; a range of silver, gold and platinum metallizing preparations including thermo-setting silver paste.

In addition a wide variety of silvered mica capacitors will be on display including a new range of low voltage types developed especially for transistorized circuitry. Over ten years ago Johnson Matthey established the first large-scale plant in the United Kingdom for the manufacture of germanium and germanium dioxide. This plant depends exclusively on domestic sources of raw materials.

Artificial Graphite

We are informed by **J. I. Oettinger** that they specialize in all kinds of artificial graphite, i.e. not only to make use of all kinds of scrap for their best recovery and use, but also in the form of billets, plates, rods or any kind of sections. It is understood that Multiple Acting Flux Ltd. are handling this business in the United Kingdom, and Ex-Trans-Im Ltd. for all foreign destinations.

Oettinger have also established in Sheffield the manufacture of colloidal graphite down to a fineness of particle size of less than 1 micron in several carriers—water, mineral oil, etc.

Oxide Refractories

From Tuesday next, May 5, until Thursday, May 7, an exhibition of "Purox" oxide refractories will be presented at the Mayfairia Rooms, Bryanston

Street, London, W.1, by **Morgan Refractories Ltd.**, a subsidiary of the Morgan Crucible Company Ltd. Recent development by the company has resulted in laboratory ware in these highly refractory materials becoming available to a greater degree of purity and in a wider range of shapes and sizes than previously.

Purity is the first consideration of "Purox" ware and the range at present includes aluminium, thoria, magnesia, and lime stabilized zirconia. Full technical details of these products may be obtained from the company at Neston, Wirral, Cheshire.

Enquiry from Singapore

It has been reported to the Board of Trade by the U.K. Trade Commissioner in Singapore that the firm of Hong Leong and Co. Ltd., of 144 Robinson Road, Singapore, are expanding their business as general importers and are anxious to get in touch with United Kingdom exporters of a number of commodities for open market business.

The items required include the following:— brass and copper sheets, tubes, etc., zinc sheets, aluminium sheets, and chemicals. Exporters interested in this enquiry are advised to communicate direct with the Singapore firm.

A London Lecture

It has been announced by the **Institute of Metals** that Professor N. J. Petch (University of Leeds) will give a lecture on "The Atomic Mechanisms of Fracture" at the headquarters of the institute, 17 Belgrave Square, London, S.W.1. at 6.30 p.m. on May 28 next.

The lecture will take the form of a report on a conference of the same title recently held at Swampscott, Mass., under the auspices of the U.S. National Academy of Sciences. Visitors will be welcome, and no tickets are required.

Price Reductions

Readjustments in the prices of their range of germanium power rectifier units, resulting in reductions of up to 33 per cent on some types have been announced by **Westinghouse Brake and Signal Company Ltd**. These reductions are made possible by improvements in manufacturing technique and increased production capacity, which enable an improved and less expensive product to be marketed.

Simultaneously with the introduction of the revised prices, a new publication (Technical Publication 601) has been issued, in which are contained full details of the existing range of germanium rectifier units.

Industrial Ovens

A new comprehensive range of gas-fired tray loading industrial ovens, with a choice of either vertical or horizontal forced air circulation, or natural convection, and of direct or indirect firing, has been recently introduced by **Barlow-Whitney Ltd.**

Standard sizes range from 8-72 ft^3 capacity, and all units incorporate the latest safety measures recommended by the Gas Council and H.M. Factory Inspectorate, including explosion reliefs and flame failure device.

Automatic temperature control is also a standard feature, and this, together with the low heat-loss factor, resulting from rigid double-skin construction and generous insulation, ensures consistent performance and high operating efficiency for the very many diverse heating processes for which such ovens are necessary, including baking, curing, drying, preheating, stoving, vulcanizing, and the like. The range covers four types, as follows:—

Series GD.300 V.A.F. are direct fired units in which the products of combustion pass through the working space. They have vertical forced air convection and operate at temperatures to 300°C.

Series GD.300 H.A.F. are similar in construction but have horizontal forced air convection, an arrangement said to be more suitable when solid trays are used for drying powders and similar applications which baffle vertical air flow.

Series GIN.200 V.A.F. have indirect firing, the products of combustion being excluded from the working space. With this series the temperature is adjustable to 200°C., and forced air convection of the vertical type ensures even distribution of heat.

Series GD.300 are direct-fired units for temperatures to 300°C. with natural draught convection. They provide a useful alternative for miscellaneous work of all kinds when initial outlay is the most important consideration and production requirements do not justify the extra cost of forced air types.

A Useful Manual

Just published by the National Industrial Fuel Efficiency Service is the New Stoker's Manual, which will serve as an introduction to the skill that is needed to operate a boiler plant satisfactorily. The changes that have taken place in the last few years have made a complete revision of the book necessary, and this new edition covers the latest developments in the mechanical firing of shell boilers with coal, and now includes a section on oil firing. As the Clean Air Act is now in force, a special section is devoted to the prevention of dark smoke. Copies of this manual (price 2s. 6d. net) may be obtained from the office of N.I.F.E.S. at 71 Grosvenor Street, London, W.1.

Standards in Industry

A one-day conference of engineers and others concerned with the application of standards in industry will be held on Thursday, June 4, at the Connaught Rooms, London, W.C.2. Applications for tickets (35s. each) should be sent to the Secretariat, I.P.E./B.S.I. Committee, British Standards House, 2 Park Street, London, W.1.

Canadian Lead and Zinc

According to a *Comtelburo* report from Montreal, Consolidated Mining and Smelting Company of Canada will curtail its exports of lead from Canada by 15,000 tons a year and its exports of zinc by 20,000 tons a year. Mr. A. O. Wolff, manager for metal sales of Consolidated, said: "We have been concerned about the serious demoralizing effect on all segments of the industry, both in Canada and abroad, of the continuing world overproduction of both lead and zinc.

"We have, therefore, decided to curtail, from June 1, deliveries to certain export markets until some measure of stability has been reached. This will result in a reduction in shipments of about 15,000 tons of lead and 20,000 tons of zinc on an annual basis." He added: "We expect that the constructive measures which have been taken by the industry through research and development, and through aggressive sales promotion, together with improved business conditions, will bring about a more realistic balance between world production and consumption, and that these cutbacks will be of relatively short duration."

U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange warehouses fell by 472 tons, and were distributed as follows at the end of last week:—London 5,141 tons, Liverpool 2,497 tons, and Hull 1,095 tons.

Stocks of refined copper rose by 175 tons and were as follows:—London 2,022 tons, Liverpool 4,144 tons, Birmingham 850 tons, and Manchester 3,300 tons.

A Luncheon Meeting

Wednesday of next week (May 6) is listed for the next luncheon meeting of the **Non-Ferrous Club**, which is to be held in the Kenilworth Room of the Queen's Hotel, Birmingham, at 12.30 p.m. The guest speaker on this occasion is to be Mr. Noel Bond-Williams, managing director of The Aston Chain and Hook Company Ltd.

Foundrymen to Visit Exhibition

Official visits by members of the Institute of British Foundrymen and representatives of other bodies connected with the foundry trade have been arranged for a series of "special days" during the **Foundry Exhibition** at Bingley Hall, Birmingham, from May 21-30.

The programme drawn up by the Exhibition Committee of the Foundry Trades' Supplies and Equipment Association, which is sponsoring the exhibition, is:—Friday, May 22—Council of the I.B.F. and Worshipful Company of Founders; Saturday, May 23—Birmingham Branch (1) of I.B.F.; Monday, May 25—Bristol, Wales and Monmouth Branches of I.B.F.; Tuesday, May 26—Newcastle, Scotland, Tees-side and Sheffield Branches of I.B.F.; Wednesday, May 27—Birmingham Branch (2) of I.B.F.; Thursday, May 28—Lancashire and West Riding Branches of I.B.F.; Friday, May 29—London Branch of I.B.F.; Saturday, May 30—East Midlands and Lincolnshire Branches of I.B.F.

In addition, special arrangements are being made for works parties from individual firms.

Die-Casting Machines

Pushing forward the design of large pressure die-casting machines and dies, the Triulzi company has designed a cylinder block for an automobile engine to be produced as a single pressure die-casting. The block has overall dimensions of approximately 20 in. in length, 13 in. in depth and 12 in. wide at the bottom. The casting bores are a little over 4 in. in diameter.

The principal of the Triulzi organization has himself visited Russia recently to discuss this design, and also the production of a pressure die-casting machine with a locking force of 2,500 tons in which the Russians are also interested.

Aluminium Alloy Balustrading

A new flyover bridge at Littlemore, constructed by the Oxfordshire County Council Highways Department, has aluminium alloy balustrading made by J. H. Grant Ltd., of Oxford. The box-section handrail is constructed of special mating sections in Noral 50SWP aluminium alloy. The intermediate rail channels and hollow rectangular stanchions are in Noral B51SWP alloy. These

extruded sections, which are bolted together, were supplied by **Northern Aluminium Company Ltd.**

It is stated that the corrosion resistance of the metal is high enough to render anodizing or painting unnecessary.

Research and Development

News from **Baird and Tatlock (London) Ltd.** is to the effect that their Research and Development Division has recently been doubled in size to keep pace with the increasing demand for the "Analmatic" equipment for automation in analysis, and for new and redesigned standard laboratory instruments and apparatus.

To deal with these two aspects of the work of the division, two main sections have been formed: they will be known as Research and Development (Analmatic Instruments) and Research and Development (General Instruments). The division, consisting of these two sections, will continue to operate under the direction of Sir Bernard Keen, D.Sc., F.Inst.P., F.R.S.

Telcothene Powder

We understand that the Plastics Division of **The Telegraph Construction and Maintenance Company Ltd.** now offers Telcothene powder for dip-coating made from Ziegler-type high density polythene. This powder, while possessing the same chemical resistance and anti-corrosive properties as the "conventional" Telcothene powder, which has been tried and proved over a number of years, has several advantages deriving from the greater mechanical strength and rigidity of high density polythene, though it also has certain limitations where the appearance of the coating is of prime importance. Its physical properties, including the higher density itself, are bound up with its chemical structure, the molecular chains being linear rather than branched, and, therefore, more closely packed together.

The softening point of high density Telcothene is about 20°C. higher than that of "conventional" Telcothene, and coatings may be kept in contact with boiling water for short periods, though the long-term working temperature should not exceed 80°C. Alternating contact with hot and cold water over a long period should be avoided.

The makers state that the superior physical properties of Telcothene H.D. recommend it especially for applications in the industrial field, where coatings capable of withstanding hard use and rough handling are called for, as, for example, hand-rails, control wheels, containers for transporting chemicals, etc. It has been used for the coating of ships' propellers, and for the internal and external coating of pipes. Any articles liable to sustain hard knocks and abrasion, as well as exposure to corrosive liquids and gases will benefit from the superior toughness and durability of Telcothene H.D. coatings. Telcothene H.D. powder is available in a wide range of colours, and colour-matching can be undertaken.

Heat-Treatment Furnace Development

Current developments in the production of endothermic atmospheres and multi-purpose furnaces for gas carburizing and carbo-nitriding were described by Mr. J. McMullen, F.I.M., chief metallurgist, **Electric Resistance Furnace Company**, at a lecture given at the Imperial Hotel, Birmingham, on Tuesday last.

The meeting, which began with dinner, was very well attended, representatives of a great number of well-known firms in the motor trade and Midland industry being present. In the discussion which followed the lecture a number of points dealing with operational practice were raised.

General Galvanizing

A new handbook, entitled "General Galvanizing: A Manual of Good Housekeeping and Safety," the third in a series of manuals on factors in galvanizing written for the Productivity Service of the Hot Dip Galvanizers' Association, has just been published by the **Zinc Development Association.**

The aim of the book is to promote good housekeeping and safety in galvanizing, and to improve the conditions in which work is carried out. After showing the benefits, both humanitarian and economic, the book illustrates how management can play its part in introducing a programme for maintaining an orderly works. Accidents are analysed, safety clothing and equipment discussed, and chapters on Safety and the Law are included.

The book is illustrated and can be obtained at the price of 25s. from the offices of the association at 34 Berkeley Square, London, W.1.

Enquiry from U.S.A.

The British Consulate-General at Cleveland, in Ohio, has informed the Board of Trade that the Lorain Automatic Screw Machine Co., of Lorain, Ohio, wishes to receive quotations from U.K. manufacturers of commercial brass rods used in the screw manufacturing industry for quantities of 5,000 lb. to 10,000 lb. of various dimensions, but not below $\frac{1}{8}$ in. or $\frac{1}{16}$ in. It is understood that the company is at present buying brass rod at approximately 31 cents per lb.

They would also like to receive quotations for 10,000 lb. quantities of round lead alloy of $1\frac{3}{16}$ in. in diameter. Interested manufacturers are invited to contact the American company direct.

Forthcoming Meetings

May 6—Institute of Metal Finishing. Scottish Branch. Institution of Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow. Annual General Meeting. 7.30 p.m.

May 6—Society of Chemical Industry. Corrosion Group, London. 14 Belgrave Square, London, S.W.1. Annual General Meeting. Chairman's Address. S. G. Clarke. 6.30 p.m.

May 7—Leeds Metallurgical Society. Lecture Room C, Chemistry Wing, The University, Leeds, 2. Annual General Meeting, followed by "Electric Melting Furnaces." F. S. Leigh, B.Sc. 7.15 p.m.

May 7 — Southampton Metallurgical Society. Small Physics Lecture Theatre, The University, Southampton. Annual General Meeting, followed by a Social Function. 7.15 p.m.

May 7—Institute of Metal Finishing. North West Branch. Engineers' Club, Albert Square, Manchester. Annual General Meeting and Panels consisting of Messrs. Pollard, Sampson, Johnson and Holiday. Question: "Do You Know Your Four P's?" 7.30 p.m.

Parliamentary News

By Our Lobby Correspondent

Non-Ferrous Foundries.—At Question Time in the Commons, Mr. Frank Allaun (Lab., Salford, E.) asked the Minister of Labour if he was aware of the concern among foundry workers over the delay in implementing the report of the Joint Standing Committee on conditions in non-ferrous foundries by the issue of appropriate regulations; and when he expected to take action.

The Parliamentary Secretary to the Ministry of Labour, Mr. Richard Wood, replied that work was proceeding on a draft Code of Regulations. It would be published and interested organizations would be asked for their comments.

Mr. Allaun said that as it was now no less than five and half years since the Joint Committee was set up, and eighteen months since the Minister had been asked about the delays in implementing its Report, had not the Amalgamated Union of Foundry Workers and others interested serious ground for complaint? As the existing iron and steel foundries Regulations would provide a helpful basis, should it not be easier to produce it quickly?

In reply, Mr. Wood said he agreed that it had taken a long time, but he did not think that the union had cause for complaint, because the Report of the Joint Committee was very long and complicated and an immense amount of consultation and discussion was necessary. They would try to speed it up as much as they could, but it was bound to take a very long time.

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Metal Market News

TRADING on the Metal Exchange last week was rather quiet, and turnovers were below average. The tone, however, was steady, and with the exception of tin, gains were registered on balance. During the second half of the week, the tin market was exceptionally quiet, the turnover on Thursday and Friday amounting only to 100 tons. Wednesday midday accounted for 315 tons, and the full count for the week was about 800 tons. It is reported that American demand is very quiet at the moment, consumers apparently feeling that there must be a fall in the tin price before long. At the close of trading on Friday afternoon, both cash and three months stood at £783, which showed a loss of £1 in cash and of £2 in three months. Stocks of tin continue to fall, and at the beginning of last week it was reported that there had been a further reduction of 421 tons to 9,205 tons. In lead, the amount changing hands was about 7,525 tons, and on balance April gained £1 15s. 0d. at £70 5s. 0d., while July closed £2 better at £71 17s. 6d. Zinc, too, was firm but the turnover amounted to only 5,200 tons, both positions gaining £2 to close at £74 5s. 0d. for April and £73 17s. 6d. for July. Both lead and zinc now look fairly steady at these lower levels and, indeed, some people feel that unless an improvement is seen soon producers may well decide to curtail their production. At the moment, the statistical position of these two metals is not very satisfactory and there is, of course, a good deal of concern in the States over this aspect of things, and the existence of import quotas is the result.

In copper, there was an advance of 50 points in the custom smelters' price to 32½ cents on the strength of a firmer tone in the American scrap market, and this influenced the London price upwards to £239 for cash and £239 10s. 0d. for three months on April 22. This, however, proved to be the top, and, following a decline on Comex, the sterling quotation fell away to close slightly above the lowest at £234 10s. 0d. cash and £235 5s. 0d. three months. It will be noticed that there was a contango of 15s., a very welcome development, due partially, no doubt, to an increase in stocks of 400 tons to 10,141 tons. On balance, the prompt position gained £1 5s. 0d. and forward £2 10s. 0d. Sales of marginal copper were reported last week to be poor on this side of the Atlantic, but it looks as though business keeps going quite well in the States. Nevertheless, so far as the March statistics are concerned it was deliveries outside the United States which showed a 23,000 tons increase, while American consumers took only 4,000 tons more than February. In this connection it must be remembered that March was a larger month than its immediate predecessor.

The excitement about the possible release of copper from the U.S. stockpile seems to have died down, and the chances are that we may not hear anything more about this for some time to come. It certainly now seems that if a decision is reached to put some of this copper on the market, the operation will be carried through with care and circumspection so that the market does not suffer. Generally speaking, it is the announcement of an intention to release copper from stock that upsets sentiment, and this has already been done. Maybe, therefore, if and when physical copper is released the price structure will not suffer unduly. Chances of a major strike at copper producing plants in the United States later in the year are still being canvassed. Elsewhere things seem fairly settled, but experience shows that only too often there is some trouble waiting round the corner.

Birmingham

At the monthly meeting of the Midland Regional Board for Industry it was stated that the improvements in both employment and vacancies between February and last month had been the biggest in a single month since two years ago. Improvements in general trade trends were continuing slowly but steadily. Moreover, measures in the Budget, especially the reinstatement of investment allowances, had given rise to optimism. Increases in industrial output were confirmed by bigger consumption of electricity at factories. A fall in unemployment has reduced the Midland unemployment percentage to 1·9 compared with a national average of 2·5. Vacancies have risen in a month from 14,662 to 18,324. The motor trade continues to prosper. Export business in cars is particularly good in North America.

The steel market shows a slight improvement, although customers are still reluctant to place new business. Consumption of sheets and castings in the motor trade is maintained. There is a slight expansion of business in the re-rolling steel trade, though there is a lot of leeway to be made up before mills can work full time. Specifications for constructional steel are only moderate. Work continues on a high scale in the establishments producing heavy electrical equipment for power stations, and for the electrification schemes of British railways. Plate mills are well employed.

New York

Copper is quiet. Custom smelters report that sales at the 32·50 cent level were extremely small. Large producers meanwhile report good demand at their price of 31·50 cents per lb. Scrap was also quiet at a buying price of a flat 26 cents per lb. One smelter quoted scrap at 25·75 cents yesterday, but moved up to the same level as others to-day. Meanwhile, usually reliable trade sources say that serious discussions are going on behind closed doors in Washington concerning the sale on the open market of copper from the Defense Production Act inventory. It was rumoured that the Cabinet Committee was scheduled to make an announcement over the week-end on this matter.

Lead and zinc were quiet. Most industry observers see little chance of concrete remedies resulting from the United Nations meetings in New York next week to consider stabilization in lead and zinc. Tin was very quiet but prices were somewhat better.

Paris

Penarroya is to rebuild its zinc plant at Noyelles-Godault, and zinc production in France will increase considerably when the new installations are operating. Over the past years considerable progress has been made in zinc metallurgy and it is now possible to prepare this metal in the same way as iron and lead, that is, in blast furnaces. The Noyelles-Godault plant, however, is still using old methods, and for that reason the plant is to be re-equipped. It is expected that the change will increase production to the highest level. It is not known yet exactly when the installations will be completed.

Moscow

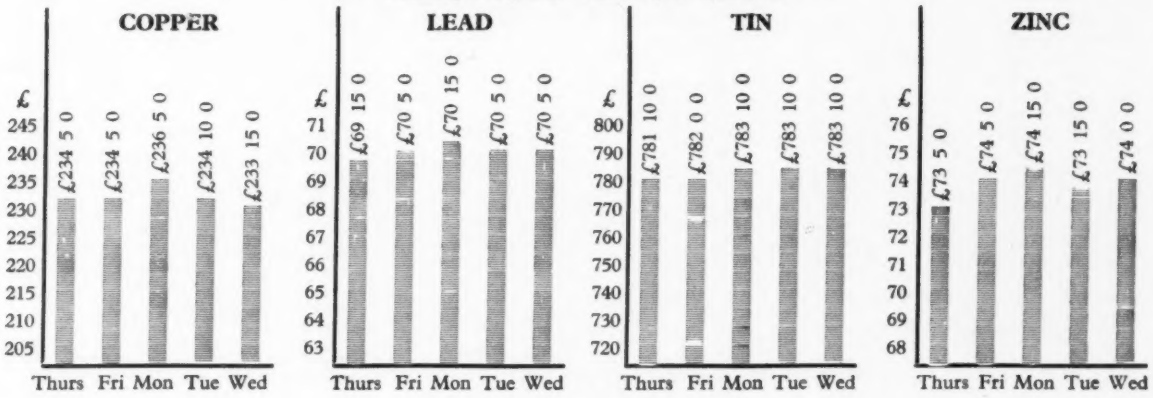
Construction and modernization of non-ferrous metal plants is generally proceeding at a satisfactory rate in the Soviet Union, according to the Economic and Industrial Gazette. It adds, however, that progress being made in the building of several aluminium works (Bogoslovsk, Sverdlovsk and Sumgait), and of copper refineries in the central Urals and at Pishinsk, is slow. Under the Seven Year Plan, electrical processes for winning metals would be increasingly applied in the Soviet non-ferrous metal industry. These processes would contribute to a substantial increase in productivity. Concentration methods would be modernized by the use of natural gas instead of solid fuel; this is expected to result in considerable savings.

The use of oxygen by smelters was another innovation which had been tested and found to be of great advantage. Thus, at the lead-zinc plant in Ust-Kamenogorsk (in Kazakhstan), coke consumption was reduced by 10 per cent by using oxygen-enriched air in the smelters. Despite these clear advantages, the setting up of oxygen plant was going very slowly, and not a single one was scheduled for installation in the non-ferrous metal plants of the Russian Republic during this year.

Non-Ferrous Metal Prices

London Metal Exchange

Thursday 23 April to Wednesday 29 April 1959



Primary Metals

All prices quoted are those available at 2 p.m. 29/4/59

		£	s.	d.
Aluminium Ingots	ton	180	0	0
Antimony 99·6%	„	197	0	0
Antimony Metal 99%	„	190	0	0
Antimony Oxide	„	180	0	0
Antimony Sulphide Lump	„	190	0	0
Antimony Sulphide Black Powder	„	205	0	0
Arsenic	„	400	0	0
Bismuth 99·95%	lb.		16	0
Cadmium 99·9%	„		9	0
Calcium	„	2	0	0
Cerium 99%	„	16	0	0
Chromium	„		6	11
Cobalt	„		14	0
Columbite	per unit		—	
Copper H.C. Electro	ton	233	15	0
Fire Refined 99·70%	„	232	0	0
Fire Refined 99·50%	„	231	0	0

		£	s.	d.
Copper Sulphate	ton	76	0	0
Germanium	grm.		—	
Gold	oz.	12	9	2
Indium	„		10	0
Iridium	„	24	0	0
Lanthanum	grm.		15	0
Lead English	ton	70	5	0
Magnesium Ingots	lb.		2	3
Notched Bar	„		2	9½
Powder Grade 4	„		6	1
Alloy Ingot, A8 or AZ91	„		2	4
Manganese Metal	ton	245	0	0
Mercury	flask	79	0	0
Molybdenum	lb.	1	10	0
Nickel	ton	600	0	0
F. Shot	lb.		5	5
F. Ingot	„		5	6
Osmium	oz.		nom.	
Osmiridium	„		nom.	

		£	s.	d.
Palladium	oz.	7	5	0
Platinum	„	28	10	0
Rhodium	„	40	0	0
Ruthenium	„	18	0	0
Selenium	lb.		nom.	
Silicon 98%	ton		nom.	
Silver Spot Bars	oz.		6	7⅛
Tellurium	lb.		15	0
Tin	ton	783	10	0
***Zinc**				
Electrolytic	ton		—	
Min 99·99%	„		—	
Virgin Min 98%	„	73	17	6
Dust 95/97%	„	109	0	0
Dust 98/99%	„	115	0	0
Granulated 99+%	„	98	17	6
Granulated 99·99+%	„	112	18	9

**Duty and Carriage to customers' works for buyers' account.*

Foreign Quotations

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

	Belgium fr/kg ≏ £/ton	Canada c/lb ≏ £/ton	France fr/kg ≏ £/ton	Italy lire/kg ≏ £/ton	Switzerland fr/kg ≏ £/ton	United States c/lb ≏ £/ton
Aluminium		22.50 185 17 6	224 163 0	375 221 5	2.50 212 10	26.80 214 10
Antimony 99.0			220 165 0	445 262 10		29.00 232 0
Cadmium			1,350 1,012 10			130.00 1,040 0
Copper						
Crude						
Wire bars 99.9				475 280 5 0		
Electrolytic	33.00 242 17 6	30.50 252 0	332 249 0		2.90 246 12 6	31.50 252 0
Lead		10.25 84 12 6	103 77 5 0	166 98 17 6	.85 74 0	11.50 92 0
Magnesium						
Nickel		70.00 578 5	900 675 0	1,200 708 0	7.50 637 10	74.00 592 0
Tin	111.00 817 2 6		1,127 845 5	1,500 885 0	9.60 816 0	102.37 818 17 6
Zinc						
Prime western		10.75 88 15 0				11.00 88 0
High grade 99.95		11.35 93 15 0				
High grade 99.99		11.75 97 0 0				
Thermic			111.00 83 5			
Electrolytic			119.00 89 5	168 99 7 6	.95 80 17 6	12.25 98 0

Non-Ferrous Metal Prices (continued)

Ingot Metals

All prices quoted are those available at 2 p.m. 29/4/59

Aluminium Alloy (Virgin)	£	s.	d.
B.S. 1490 L.M.5 .... ton	210	0	0
B.S. 1490 L.M.6 .... „	202	0	0
B.S. 1490 L.M.7 .... „	216	0	0
B.S. 1490 L.M.8 .... „	203	0	0
B.S. 1490 L.M.9 .... „	203	0	0
B.S. 1490 L.M.10.... „	221	0	0
B.S. 1490 L.M.11.... „	215	0	0
B.S. 1490 L.M.12.... „	223	0	0
B.S. 1490 L.M.13.... „	216	0	0
B.S. 1490 L.M.14.... „	224	0	0
B.S. 1490 L.M.15.... „	210	0	0
B.S. 1490 L.M.16.... „	206	0	0
B.S. 1490 L.M.18.... „	203	0	0
B.S. 1490 L.M.22.... „	210	0	0

†Aluminium Alloys (Secondary)			
B.S. 1490 L.M.1 .... ton			—
B.S. 1490 L.M.2 .... „			—
B.S. 1490 L.M.4 .... „			—
B.S. 1490 L.M.6 .... „			—

***Aluminium Bronze**				
BSS 1400 AB.1.....	ton	232	0	0
BSS 1400 AB.2.....	„	237	0	0

***Brass**		£	s.	d.
BSS 1400-B3 65/35 ..	ton	156	0	0
BSS 249	„		—	
BSS 1400-B6 85/15 ..	„	200	0	0

***Gunmetal**				
R.C.H. 3/4% ton	„		—	
(85/5/5/5)	„	194	0	0
(86/7/5/2)	„	205	0	0
(88/10/2/1)	„	240	0	0
(88/10/2/½)	„	259	0	0

***Manganese Bronze**				
BSS 1400 HTB1....	„	188	0	0
BSS 1400 HTB2....	„	204	0	0
BSS 1400 HTB3....	„	208	0	0

Nickel Silver				
Casting Quality 12%	„	225	0	0
„ „ 16%	„	235	0	0
„ „ 18%	„	250	0	0

***Phosphor Bronze**				
B.S. 1400 P.B.1.(A.I.D. released)	„	286	0	0
B.S. 1400 L.P.B.1	„	213	0	0

**Average prices for the last week-end.*

Phosphor Copper		£	s.	d.
10%	ton	253	0	0
15%	„	255	10	0

Phosphor Tin			
5%	„		—

Silicon Bronze				
BSS 1400-SB1	„	251	0	0

Solder, soft, BSS 219				
Grade C Tinmans....	„	364	15	0
Grade D Plumbers..	„	293	10	0
Grade M	„	400	10	0

Solder, Brazing, BSS 1845			
Type 8 (Granulated)	lb.		—
Type 9 „	„		—

Zinc Alloys				
Mazak III	ton	105	3	9
Mazak V	„	109	3	9
Kayem	„	115	3	9
Kayem II	„	121	3	9
Sodium-Zinc	lb.		2	6

Semi-Fabricated Products

Prices vary according to dimensions and quantities. The following are the basis prices for certain specific products.

Aluminium				
Sheet 10 S.W.G.	lb.		2	8½
Sheet 18 S.W.G.	„		2	10½
Sheet 24 S.W.G.	„		3	1½
Strip 10 S.W.G.	„		2	8½
Strip 18 S.W.G.	„		2	9½
Strip 24 S.W.G.	„		2	11
Circles 22 S.W.G.	„		3	2½
Circles 18 S.W.G.	„		3	1½
Circles 12 S.W.G.	„		3	0½
Plate as rolled	„		2	8
Sections	„		3	2
Wire 10 S.W.G.	„		2	11½
Tubes 1 in. o.d. 16 S.W.G.	„		4	1

Aluminium Alloys				
BS1470. HS10W.				
Sheet 10 S.W.G.	„		3	1
Sheet 18 S.W.G.	„		3	3½
Sheet 24 S.W.G.	„		3	11
Strip 10 S.W.G.	„		3	1
Strip 18 S.W.G.	„		3	2½
Strip 24 S.W.G.	„		3	10½
BS1477. HP30M.				
Plate as rolled.....	„		2	11
BS1470. HC15WP.				
Sheet 10 S.W.G.	„		3	9½
Sheet 18 S.W.G.	„		4	2
Sheet 24 S.W.G.	„		5	0½
Strip 10 S.W.G.	„		3	10½
Strip 18 S.W.G.	„		4	2
Strip 24 S.W.G.	„		4	9½
BS1477. HPC15WP.				
Plate heat treated..	„		3	6½
BS1475. HG10W.				
Wire 10 S.W.G.	„		3	10½
BS1471. HT10WP.				
Tubes 1 in. o.d. 16 S.W.G.	„		5	0½
BS1476. HE10WP.				
Sections	„		3	1½

Brass				
Tubes.....	„		1	10½
Brazed Tubes.....	„		—	
Drawn Strip Sections	„		—	
Sheet	ton		—	
Strip	„	252	5	0
Extruded Bar.....	lb.		2	0½
Extruded Bar (Pure Metal Basis)	„		—	

Brass				
Condenser Plate (Yellow Metal)	ton	187	0	0
Condenser Plate (Naval Brass)	„	199	0	0
Wire	lb.		2	7½

Beryllium Copper				
Strip	„	1	4	11
Rod.....	„	1	1	6
Wire	„	1	4	9

Copper				
Tubes	lb.		2	3½
Sheet	ton	265	15	0
Strip	„	265	15	0
Plain Plates	„		—	
Locomotive Rods	„		—	
H.C. Wire	„	285	5	0

Cupro Nickel				
Tubes 70/30	lb.		3	6¾

Lead				
Pipes (London)	ton	111	5	0
Sheet (London)	„	109	0	0
Tellurium Lead	„	£6 extra		

Nickel Silver			
Sheet and Strip 7% ..	lb.	3	8
Wire 10%	„	4	2¾

Phosphor Bronze			
Wire	„	4	1

Titanium (1,000 lb. lots)		
Billet over 4″ dia.-18″ dia.	lb.	63/- 64/-
Rod 4″ dia.-·250″ dia.	„	75/- 112/-
Wire under ·250″ dia.-·036″ dia.	„	146/- 222/-
Sheet 8′ × 2′ × ·250″-·010″	„	88/- 157/-
Strip ·048″-·003″.....	„	100/- 350/-
Tube.....	„	300/-
Extrusions	„	120/-

Zinc				
Sheet	ton	110	5	0
Strip	„		nom.	

Domestic and Foreign

Merchants' average buying prices delivered, per ton, 28/4/59.

Aluminium	£
New Cuttings	146
Old Rolled	126
Segregated Turnings	98

Brass	
Cuttings	155
Rod Ends	143
Heavy Yellow	126
Light	121
Rolled	145
Collected Scrap	124
Turnings	137

Copper	
Wire	213
Firebox, cut up	210
Heavy	205
Light	200
Cuttings	213
Turnings	196
Braziery	164

Gunmetal	£
Gear Wheels	183
Admiralty.....	183
Commercial.....	165
Turnings	160

Lead	
Scrap	59

Nickel	
Cuttings	—
Anodes	550

Phosphor Bronze	
Scrap	165
Turnings	160

Zinc	
Remelted	63
Cuttings	53
Old Zinc	37

Financial News

Amber Chemical Industries

Group profit, 1958, £7,908 (£17,472), before tax. Preference arrears for 1954 £2,875 (same). Debit forward £67,221 (£71,803). Fixed assets £77,747 (£50,328). Current assets £218,495 (£199,887), liabilities £144,156 (£109,750). Mortgage loan £10,000 (nil).

Metal Box Company

It has been announced by the company that its subsidiary, Metal Box Company Overseas, has acquired over 90 per cent of the capital of the Italian associate, La Superbox Fabbrica Contenitori Metallici S.P.A. The balance of the capital is held by Metal Box Associates in France and America.

Tharsis Sulphur and Copper

Net profit, 1958, £122,728 (£220,234) and dividend 12½ per cent (same). Fixed assets £1,523,647 (£1,412,886). Current assets £2,068,833 (£2,197,355) and liabilities £663,639 (£735,030), of which overdraft £235,159.

McKechnie Brothers Limited

The directors have declared an interim dividend of 5 per cent on the company's Ordinary and "A" Ordinary shares on account of the year ending July 31, 1959. Such dividend will be paid on May 30 to members on the register as at the close of business on May 14.

Malayan Tin

The world's largest open-cast tin mine, the Hong Fatt (Sungei Besi) Limited, in Malaya, reported a loss last year, the first full year of operation under the tin control restrictions. The loss totalled 174,000 Malayan dollars after writing off 221,457 dollars from accumulated development expenditures. As a result, no dividends were paid. Mr. W. T. Dunne, chairman of the company, said in his report that shareholders should not expect any great improvement in the company's financial position until the production quota releases were increased. The company retrenched 289 labourers in the year. Production for the year totalled 7,360 piculs, compared with 9,822 piculs in the previous year.

British Rollmakers

Group profit, after tax, 53 weeks to January 3, 1959, £467,016 (£415,333 for year), dividend 15 per cent (14 per cent), and one-for-four scrip issue proposal. Fixed assets £3,256,601 (£2,810,678). Net current assets £1,733,126 (£1,782,574). Deferred tax liabilities £660,994 (£631,747). Commitments £532,000 (£413,000).

Falconbridge Nickel

Net income of Falconbridge Nickel Mines Limited for the first quarter of 1959 about equalled the like period of 1958, Mr. H. J. Fraser, President, said following the company's annual meeting. For the full year, he said, while it was still too early to be definite, "I wouldn't expect results to be too much different from 1958." For the year ended December 31, 1958, the company had a net income of 7,053,209 dollars, or 1·88 dollars per share. Total metal sales and other operating revenues were 56,755,666 dollars.

Noranda Mines

Net income of Noranda Mines in the first quarter of 1959 is put at 57 cents a share compared with 49 cents in the first quarter of 1958. Disclosing this at the annual meeting in Toronto, Mr. John R. Bradfield, President, said the outlook had improved with better copper prices, higher returns from the Cutler Acid plant, and the closing of the Port Robinson sulphur-iron plant. Mr. R. V. Porritt, vice-president and general manager, said no progress had been made on renewal of the agreement with the workers' union, which had expired on April 10 and was now in the conciliation stage.

Follsain-Wycliffe Foundries

At the 25th annual general meeting of the company, held this week, the chairman, in the course of his circulated statement, said that it was intended in the early future to ask shareholders to approve measures whereby the company would cease its trading activities and become the parent of two subsidiary trading companies. If this were approved, a substantial improvement in the administration of the group could be obtained.

Scrap Metal Prices

The figures in brackets give the English equivalents in £1 per ton:—

West Germany (D-marks per 100 kilos):

Used copper wire ..	(£205.17.6)	235
Heavy copper	(£201.10.0)	230
Light copper	(£175.5.0)	200
Heavy brass	(£118.5.0)	135
Light brass	(£92.0.0)	105
Soft lead scrap	(£57.0.0)	65
Zinc scrap	(£36.15.0)	42
Used aluminium unsorted	(£83.5.0)	95

France (francs per kilo):

Electrolytic copper scrap	(£191.5.0)	255
Heavy copper	(£191.5.0)	255
No. 1 copper wire ..	(£180.0.0)	240
Light brass	(£112.12.6)	150
Zinc castings	(£48.15.0)	65
Lead	(£64.12.6)	86
Aluminium	(£120.0.0)	160

Italy (lire per kilo):

Aluminium soft sheet clippings (new) ..	(£197.12.6)	335
Aluminium copper alloy	(£126.17.6)	215
Lead soft, first quality	(£75.12.6)	128
Lead, battery plates	(£41.17.6)	71
Copper, first grade	(£221.5.0)	375
Copper, second grade	(£209.10.0)	355
Bronze, first quality machinery	(£206.12.0)	350
Bronze, commercial gunmetal	(£183.0.0)	300
Brass, heavy.....	(£144.10.0)	245
Brass, light	(£129.17.6)	220
Brass, bar turnings ..	(£132.15.0)	225
New zinc sheet clippings	(£51.5.0)	97
Old zinc	(£42.10.0)	72

Trade Publications

Pipe Bending.—Chamberlain Industries Ltd., Staffa Road, Leyton, London, E.10.

A manual on pipe bending has been issued by this company in which is given information on various aspects of pipe bending for steam, gas and copper tubes.

Protection Against Corrosion. — I.M.P.A. Limited, Barnbrook Works, Fountain Street, Barnbrook, Bury, Lancs.

This new catalogue covers the chemical-resistant thermoplastics — polythene, P.V.C., fluon, nylon, etc. The contents are set up on loose sheets and follow in sequence under a series of eight headings, as follows: polythene—general; polythene fittings; polythene seamless containers; rigid P.V.C.—general; nylon—general; fluon—general; polypropylene, and chemical resistance.

Aluminium Alloy Rod. — Imperial Chemical Industries Limited, Metals Division, P.O. Box 216, Birmingham, 6.

An illustrated leaflet describes "Kynal" 11S free-machining aluminium alloy rod. Kynal 11S is a medium-strength heat-treatable alloy which possesses excellent free-machining properties, making it eminently suitable for high-speed automatic work.

Chemical Plants —Chemical Construction (G.B.) Ltd., 9 Henrietta Place, London, W.1.

Two interesting new brochures have recently been issued by this company. One contains the history of the company, its engineering and construction organization, a list of processes, research and development, its various achievements. It is accompanied by many excellent diagrams and illustrations.

The second brochure gives details and illustrations of the London headquarters of the company, showing various departments, and also a map of the world depicting the location of some of the 1,200 Chemico projects—completed and under construction—in various parts of the world.

Speedicut Tools.—Firth Brown Tools Ltd., Carlisle Street East, Sheffield.

An eight-page booklet illustrates and describes this company's Speedicut type A tipholder and their C.101 cemented oxide inserts. Prices of these additions to the company's range of engineers' cutting tool are also shown, together with general instructions and recommendations for using these to the best advantage.

Protective Clothing. — Plysu Products Limited, Woburn Sands, Bletchley, Bucks.

This brochure describes pressure ventilated clothing which was first introduced to provide light, comfortable and inexpensive protection from radioactive dust in certain sections of the United Kingdom Atomic Energy Authority. There are many other applications in industry for this type of protective clothing, particularly where airborne contamination, such as toxic smoke, gas or dust particles present a hazard.

I.C.I. Titanium. — Imperial Chemical Industries Limited, Metals Division, P.O. Box 216, Birmingham, 6.

Two useful leaflets drawing attention to this company's production of titanium for use in chemical plant and for the aircraft industry. Technical data and interesting photographs are included.

THE STOCK EXCHANGE

Account Ended With Profit-taking In Evidence But Undertone Very Firm

ISSUED CAPITAL •	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 28 APRIL	+RISE—FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV YEAR	DIV. YIELD	1959 HIGH	1959 LOW	1958 HIGH	1958 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	26/6		9	10	6 15 9	27/–	23/3	24/9	17/6
400,000	2/–	Anti-Attrition Metal	1/6		4	8¼	5 6 9	—	—	1/9	1/3
41,305,038	Stk. (£1)	Associated Electrical Industries ...	61/–	+6d.	15	15	4 18 3	61/9	54/–	58/9	46/6
1,609,032	1	Birfield	47/9	—3d.	15	15	6 5 9	59/–	47/6	62/4½	46/3
3,196,667	1	Birmid Industries	74/9	—3d.	17½	17½	4 13 6	76/10½	72/–	77/6	55/3
5,630,344	Stk. (£1)	Birmingham Small Arms	41/9	+6d.	11	10	5 5 3	41/9	36/1½	39/–	23/9
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	16/3		5	5	6 3 0	16/3	15/–	16/1½	14/7½
350,580	Stk. (£1)	Ditto Cum. B. Pref. 6%	17/9		6	6	6 15 3	18/1½	17/9	17/4½	16/6
500,000	1	Bolton (Thos.) & Sons	30/–	+2/6	10	12½	6 13 3	30/–	27/6	28/9	24/–
300,000	1	Ditto Pref. 5%	15/6		5	5	6 9 0	15/6	15/–	16/–	15/–
160,000	1	Booth (James) & Co. Cum. Pref. 7%	20/–	—6d.	7	7	7 0 0	—	—	20/4½	19/–
1,500,000	Stk. (£1)	British Aluminium Co. Pref 6% ...	19/6		6	6	6 3 0	19/7½	18/9	20/–	18/4½
15,000,000	Stk. (£1)	British Insulated Callender's Cables	56/–	+3/6	12½	12½	4 9 3	56/–	47/6	52/6	38/9
17,047,166	Stk. (£1)	British Oxygen Co. Ltd., Ord. ...	57/3	+2/3	10	10	3 10 0	57/3	49/3	52/–	28/3
600,000	Stk. (5/–)	Canning (W.) & Co.	31/9	+1/–	25+ *2½C	25	4 1 9	31/9	24/9	25/3	19/3
60,484	1/–	Carr (Chas.)	1/10½		12½	25	6 13 3	2/3	1/3	2/3	1/4½
150,000	2/–	Case (Alfred) & Co. Ltd.	5/–		25	25	10 0 0	5/3	4/7½	5/3	4/–
555,000	1	Clifford (Chas.) Ltd.	23/6	+6d.	10	10	8 10 3	23/6	22/6	22/–	16/–
45,000	1	Ditto Cum. Pref. 6%	16/-		6	6	7 10 0	16/–	15/3	16/–	15/–
250,000	2/–	Coley Metals	4/–	+7½d.	20	25	10 0 0	4/–	2/10½	4/6	2/6
8,730,596	1	Cons. Zinc Corp.†	6C/–	—6d.	18¾	22½	6 5 0	67/6	60/–	65/3	41/–
1,509,528	1	Davy & United	97/9	+9d.	20	15	4 1 9	97/9	86/–	87/–	45/9
2,915,000	5/–	Delta Metal	33/4½	—3d.	31	30	4 13 0	33/7½	24/1½	25/–	17/7½
4,600,000	Stk. (£1)	Enfield Rolling Mills Ltd.	47/9	+2/9	15	12½	6 5 9	48/–	36/7½	38/–	22/9
750,000	1	Evered & Co.	31/6		10 §	15 Z	6 7 0	31/6	30/–	30/–	26/
18,000,000	Stk. (£1)	General Electric Co.	32/–		10P	12½		40/3	30/9	40/6	29/6
1,500,000	Stk. (10/–)	General Refractories Ltd	33/–	—9d.	20	20	6 1 3	40/–	33/–	39/3	27/3
401,240	1	Gibbons (Dudley) Ltd.	64/–		15	15	4 13 6	66/6	64/–	67/6	61/–
750,000	5/–	Glacier Metal Co. Ltd.	7/3	+3d.	11½	11½	7 18 6	7/3	6/7½	8/3	5/–
1,750,000	5/–	Glynwed Tubes	19/–	+1½d.	20	20	5 5 3	19/3	16/4½	18/1½	12/10½
5,421,049	10/–	Goodlsss Wall & Lead Industries ...	34/–	+3d.	13‖	18Z	3 16 6	34/–	28/7½	30/9	17/3
342,195	1	Greenwood & Batley	81/9		20	17½	4 18 0	83/9	75/–	57/9	45/–
396,000	5/–	Harrison (B'ham) Ord.	18/–		*17½	*15	4 17 3	18/9	14/11½	15/9	11/6
150,000	1	Ditto Cum. Pref. 7%	19/6		7	7	7 3 6	—	—	19/9	18/4½
1,075,167	5/–	Heenan Group	8/3	+1½d.	10	10‡	6 1 3	8/6	7/6	9/7½	6/9
236,938,260	Stk. (£1)	Imperial Chemical Industries ...	34/9	+1/–	12Z	10	4 12 0	38/3	33/9	38/–	24/3
34,736,773	Stk. (£1)	Ditto Cum. Pref. 5%	17/1½	+1½d.	5	5	5 16 9	17/1½	16/–	17/1½	16/–
14,584,025	**	International Nickel	163	+½	$2.60	$3.75	2 17 0	171	153	169	132¾
860,000	5/–	Jenks (E. P.), Ltd.	9/10½	+1½d.	14	27½ϕ	7 1 9	10/–	8/9	10/–	6/7½
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	16/3		5	5	6 3 0	16/3	15/4½	16/9	15/–
3,987,435	1	Ditto Ord.	48/6	+1/6	10	10	4 2 6	52/6	44/3	47/–	36/6
600,000	10/–	Keith, Blackman	28/9	+3d.	17½E	15	6 1 9	28/9	25/–	28/9	15/–
320,000	4/–	London Aluminium	5/4½	—3d.	10	10	7 8 9	6/4½	5/3	6/–	3/–
765,012	1	McKechnie Brothers Ord.	42/6		15	15	7 1 3	45/–	42/6	45/–	32/–
1,530,024	1	Ditto A Ord.	40/–		15	15	7 10 0	43/6	40/–	45/–	30/–
1,108,268	5/–	Manganese Bronze & Brass	16/3	+9d.	20	27½‡	6 3 0	16/3	13/9	14/1½	8/9
50,628	6/–	Ditto (7½% N.C. Pref.)	6/–		7½	7½	7 10 0	—	—	6/3	5/6
13,098,855	Stk. (£1)	Metal Box	75/9	—6d.	11	11	2 18 3	78/9	66/6	73/3	40/6
415,760	Stk. (2/–)	Metal Traders	9/9		50	50	10 5 3	9/9	8/4½	9/–	6/3
160,000	1	Mint (The) Birmingham	25/–	+1/–	10	10	8 0 0	25/–	22/–	22/9	19/–
80,000	5	Ditto Pref. 6%	72/6		6	6	8 5 6	75/6	69/–	83/6	69/–
3,705,670	Stk. (£1)	Morgan Crucible A	46/6	+6d.	10	10	4 6 0	46/6	43/6	45/–	34/–
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	17/6		5½	5½	6 5 9	18/6	17/6	18/–	17/–
2,200,000	Stk. (£1)	Murex	47/9	—1/6	17½	20	7 6 9	50/–	42/–	58/9	46/–
468,000	5/–	Ratcliffs (Great Bridge)	11/3		10R	10	4 9 0	11/6	10/4½	11/1½	6/10½
234 960	10/–	Sanderson Bros. & Newbould ...	31/6	+6d.	20	27½D	6 7 0	31/6	27/9	27/3	24/6
1,365,000	Stk. (5/–)	Sarck	20/3	—1½d.	15	17½	3 14 0	20/8½	18/–	18/7½	11/–
6,698,586	Stk. (£1)	Stone-Platt Industries	51/3	+1/6	15	12½	5 17 0	51/3	43/3	45/6	22/6
2,928 963	Stk. (£1)	Ditto 5½% Cum. Pref.	17/6	+6d.	5½	5½	6 5 9	17/6	15/10½	16/3	12/7½
18,255,218	Stk. (£1)	Tube Investments Ord.	82/4½	—1/10½	17½	15	4 2 9	85/–	72/–	86/–	48/4½
41,000,000	Stk. (£1)	Vickers	35/–	+7½d.	10	10	5 14 3	37/–	30/6	36/3	28/9
750,000	Stk. (£1)	Ditto Pref. 5%	14/6		5	5	6 18 0	15/0½	14/6	15/9	14/3
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	21/–	—6d.	*5	*5	7 2 9A	22/7½	21/–	23/–	21/3
2,200,000	1	Ward (Thos. W.), Ord.	87/9	+3d.	20	15	4 11 0	87/9	83/6	87/3	70/9
2,666,034	Stk. (£1)	Westinghouse Brake	44/–		10	10	4 11 0	47/–	39/9	46/6	32/6
225,000	2/–	Wolverhampton Die-Casting ...	10/3		30	25	5 17 0	10/6	8/8½	10/1½	7/–
591,000	5/–	Wolverhampton Metal	26/9	—1/9	27½	27½	5 2 9	28/6	21/6	22/9	14/9
78,465	2/6	Wright, Bindley & Gell	5/10½	—7½d.	20	20	8 10 3	6/7½	4/11½	5/4½	2/9
124,140	1	Ditto Cum. Pref. 6%	13/9		6	6	8 14 6	13/9	13/6	13/–	11/3
150,000	1/–	Zinc Alloy Rust Proof	3/–		27	40D	9 0 0	3/1½	2/9	3/1½	2/7½

*Dividend paid free of Income Tax. †Incorporating Zinc Corpn. & Imperial Smelting **Shares of no Par Value. ‡ and 100% Capitalized Issue. •The figures given relate to the issue quoted in the third column. A Calculated on £7 14 6 gross. Y Calculated on 11½% dividend. ‖Adjusted to allow for capitalization issue. E for 15 months. D and 50% capitalized issue. Z and 50% capitalized issue. B equivalent to 12½% on existing Ordinary Capital after 100% capitalized issue. ϕ And 100% capitalized issue. X Calculated on 17½%. C Paid out of Capital Profits. E and 50% capitalized issue in 7% 2nd Pref. Shares. P Interim dividend since reduced. § And Special distribution of 2½% free of tax. R And proposed 33⅓% capitalized issue in 8% Maximum Ordinary 5/– Stock Units.

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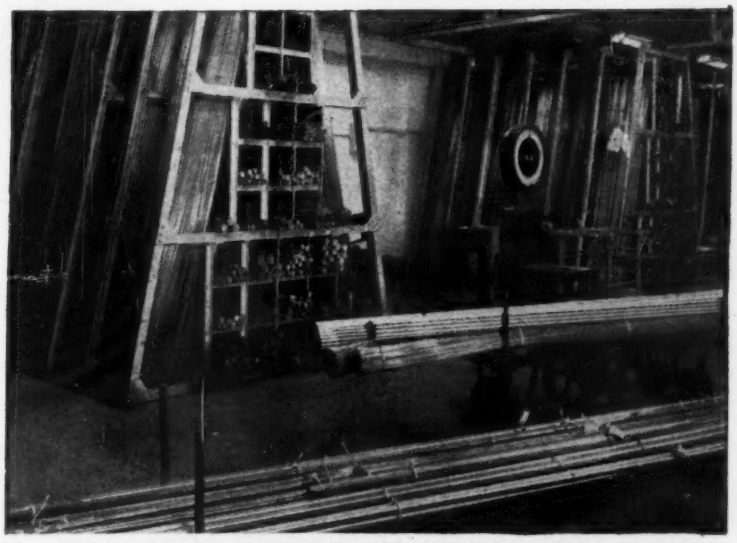

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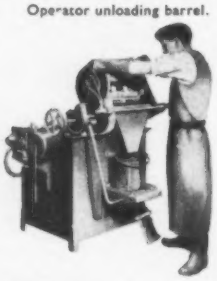

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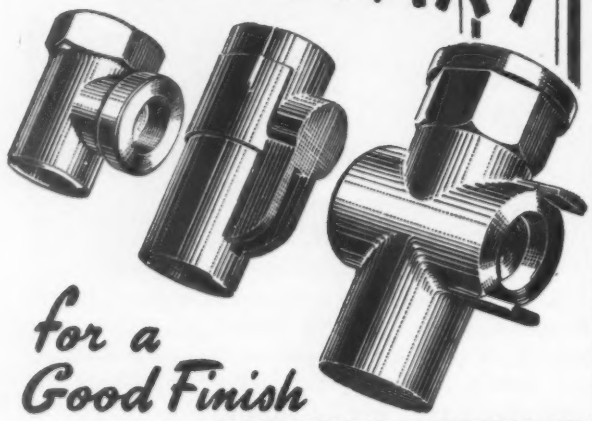

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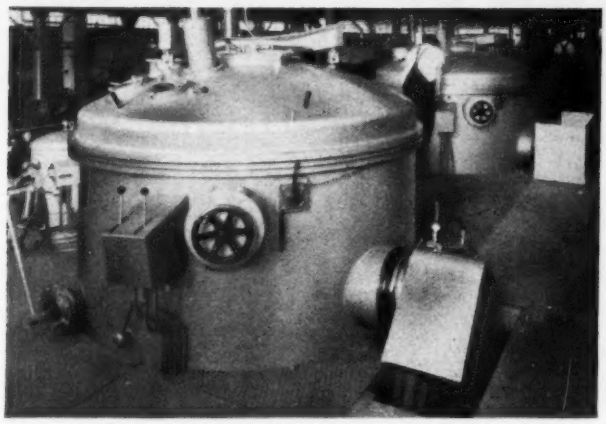

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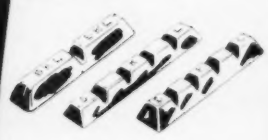

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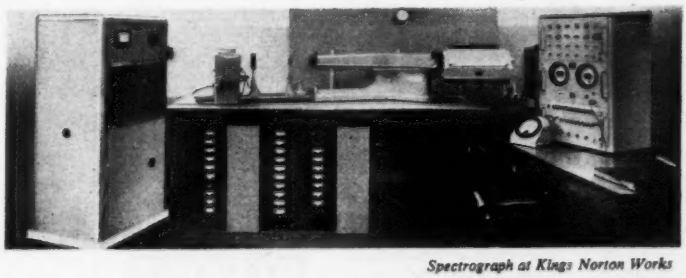

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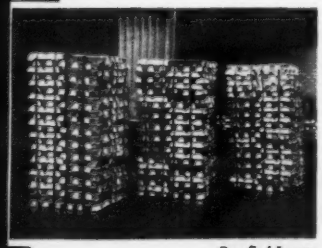

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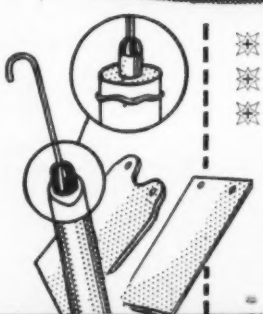

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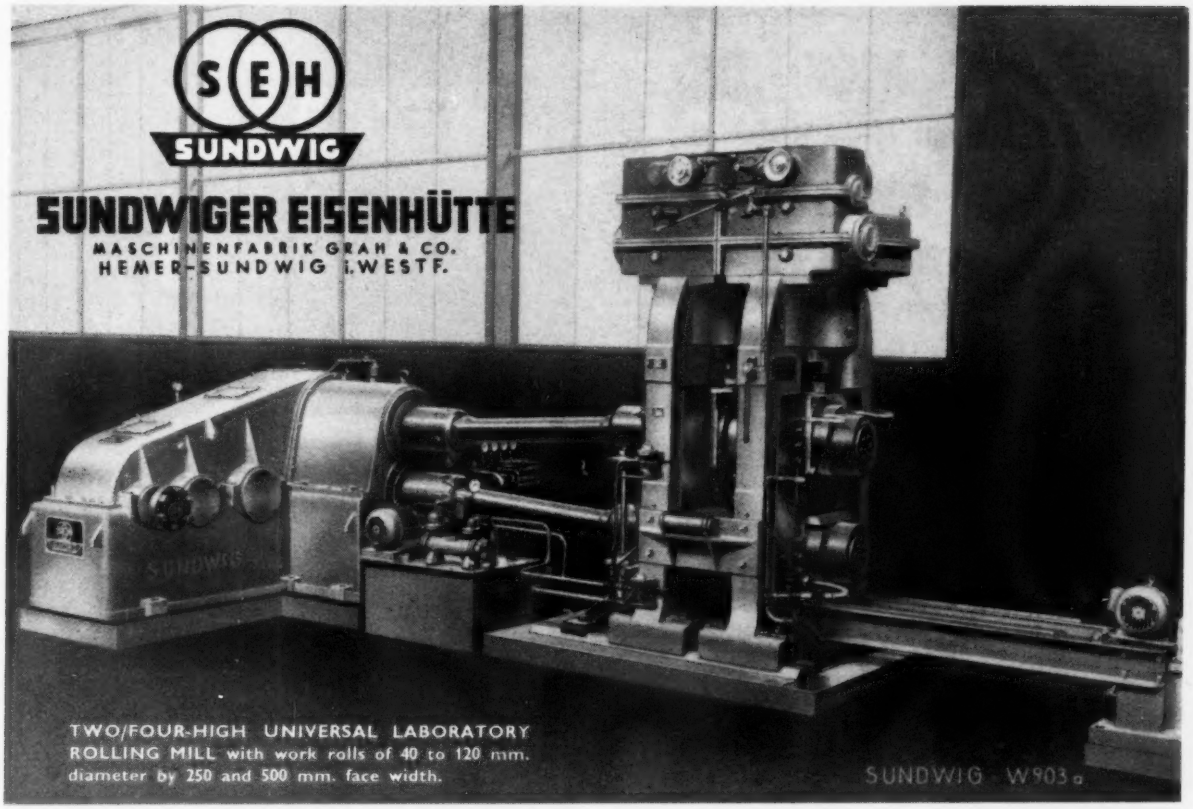
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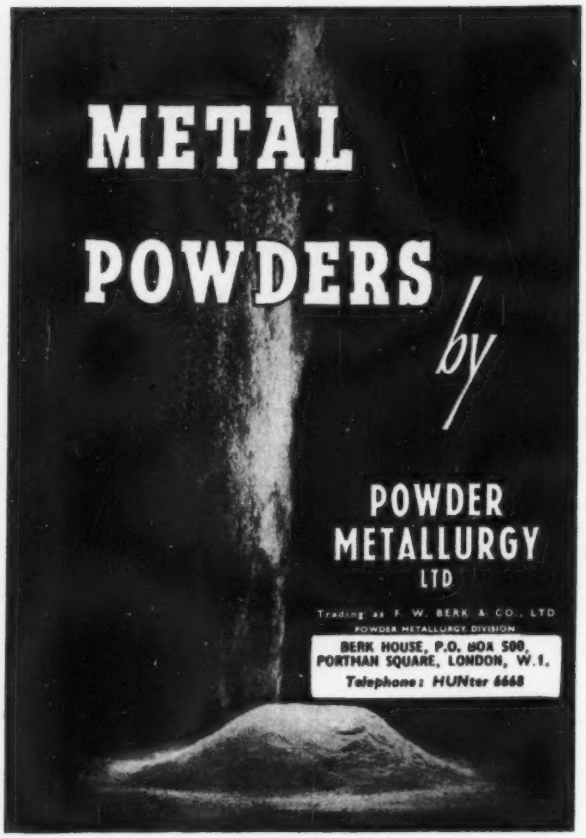

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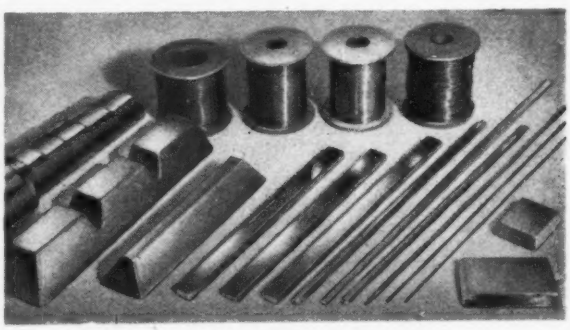

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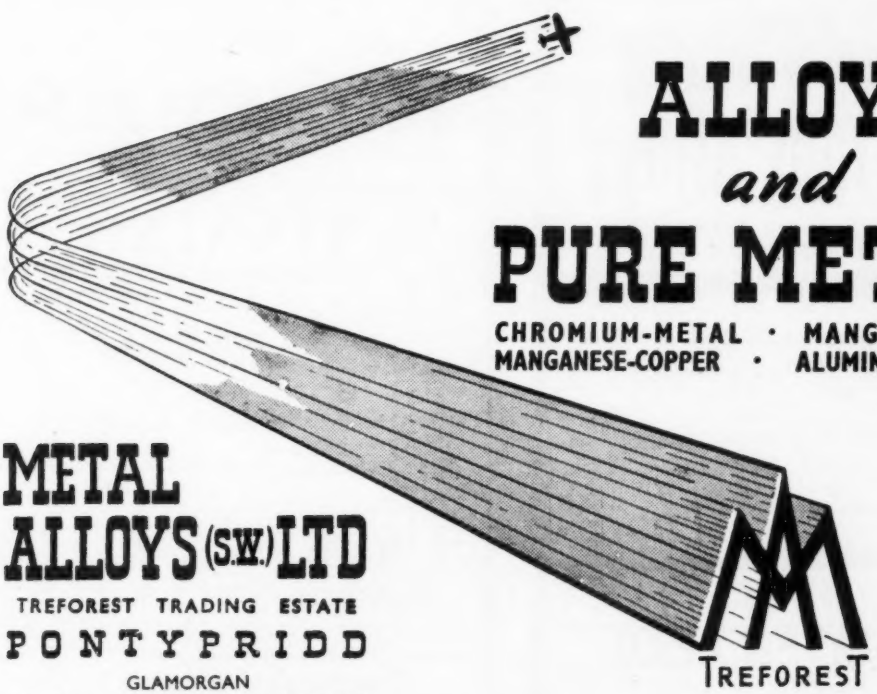

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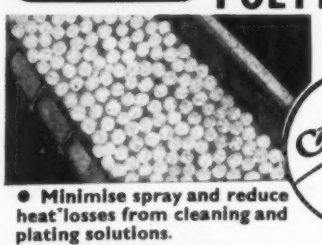

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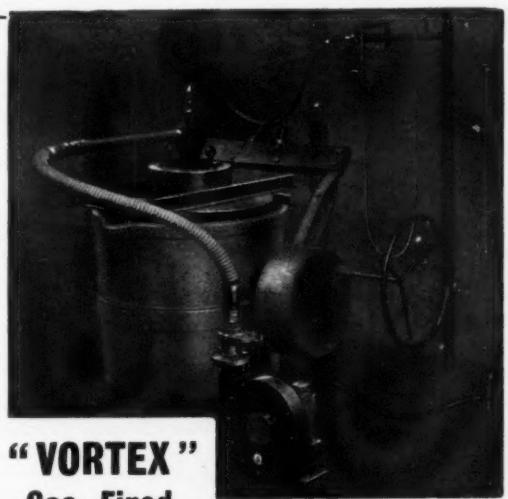

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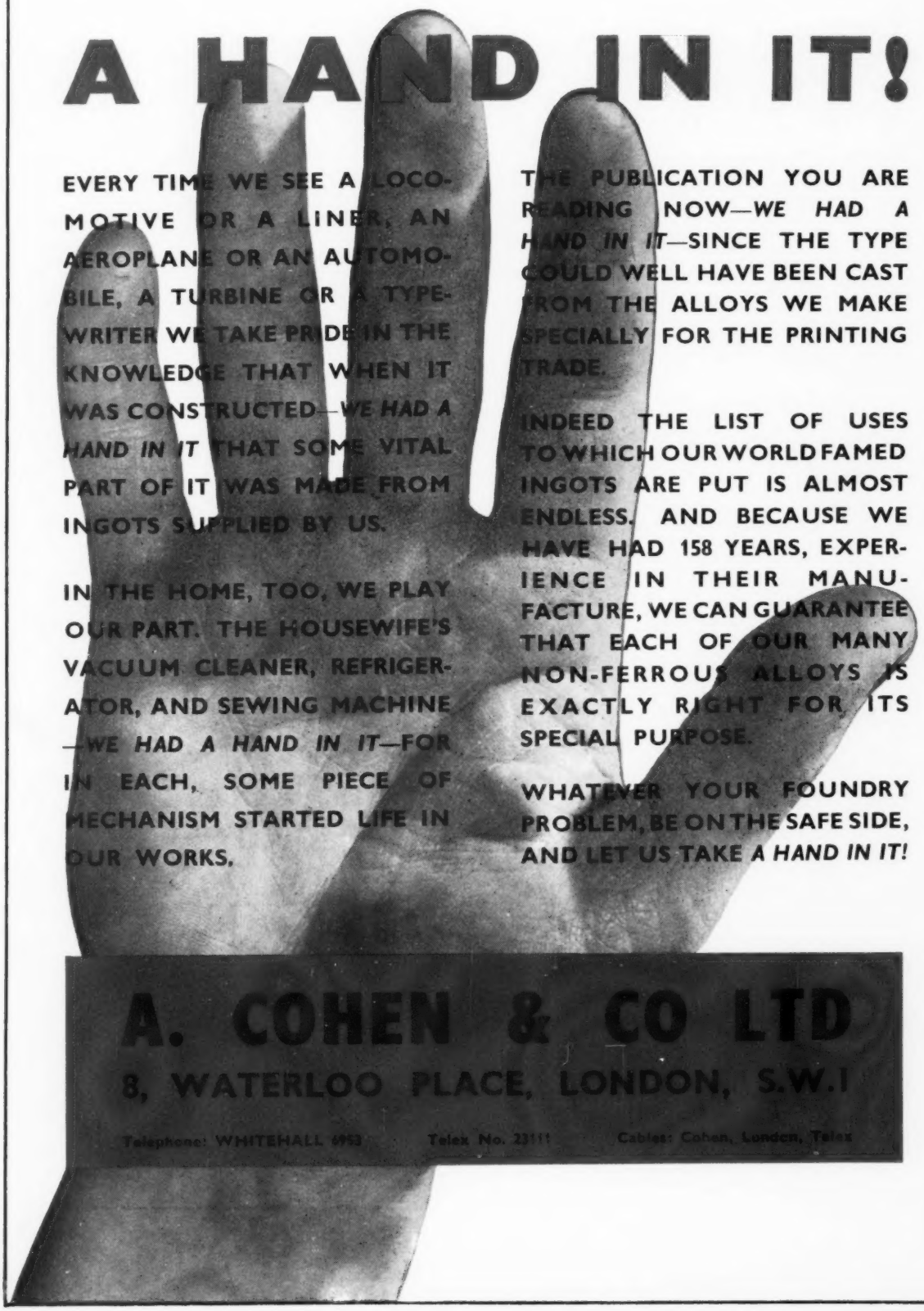

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